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PNEUMOCONIOSIS IN THE TALC INDUSTRY

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IN PRESENTING the following 15 cases with 5 postmortem examinations, an effort is made to correlate as to cause and effect the dusty occupation of talc mining and milling with a definite morbidity. The cases have been employees of either of two local talc producing companies, one of which was surveyed and reported by Dreessen[5] in 1933.

Dreessen found the silicates, tremolite and soapstone, to be present in approximately equal amounts and found no free silica. All of the particles of silicate dust were smaller than 6 microns in diameter, and 68 per cent did not exceed 2 microns. The highest dust concentration, 1,444 million particles per cubic foot, was found at breathing level in the vicinity of pneumatic drills; the average count in the mills was 52 million particles, and in some other locations a count as low as 4 million was found. Non-disabling pulmonary fibrosis was found in nearly all of the workers examined.

As compared with free silica the silicates, other than asbestos, have received scant attention as a possible occupational hazard. Few efforts have been made to incriminate them and there has been denial of their pathogenicity. Gardner[9] as recently as 1940, discussing pneumoconiosis, has stated that only free silica and asbestos are capable of producing fibrosis in a normal lung. Miller and Sayers,[16] injecting various dusts intraperitoneally into experimental animals, found the silicates to be inert in producing tissue response in contradistinction to the fibrous tissue produced by silica. Deaner[4] reported a typical silicosis occurring among the miners of fireclay, a silicate industry, the chief clinical symptom being dyspnea. The lesions found by roentgen and postmortem examinations were attributed to occasional grains of a contaminating quartz dust. The predominating silicate dust was not emphasized as a possible factor.

The earliest reference we have found to the pathogenicity of the silicates is in a report of Badham[1] who noted a "fine diffused fibrosis, without clear spaces of normal lung" to be a common roentgenographic finding among miners of New South Wales exposed to silicate dust. He named the condition silicatosis and observed dyspnea and clubbing of the fingers. It was his opinion that the condition was mechanically more damaging than the coarser nodular fibrosis of silicosis and he reported one case progressing to a fatal termination within two years from the time of his original examina-

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tion. McNally and Trostler[15] had under prolonged observation the plant and workers of an industry producing a silicate, fullers' earth. They found by roentgen examination a high incidence of pulmonary fibrosis, and of 49 persons examined, 2 had extensive changes and were disabled. Dreessen and DallaValle,[6] in surveying two Georgia talc mills and mines in which dust concentrations varied from 32 million to 1,672 million particles per cubic foot, found in 66 persons examined, 8 having advanced pneumoconiosis with disability, and 14 additional having roentgenographically demonstrated slight pneumoconiosis without disability. This talc was shown by analysis to consist chiefly of soapstone, and they state that in comparison with the analysis reported by Dreessen,[5] Georgia talc appeared to be more injurious than tremolite talc.

The report of Eason, Trice and Carpenter[7] of the pyrophyllite industry in North Carolina is most comprehensive, being especially interesting in regard to previously existing and corrected conditions of mining and processing. Pyrophyllite is described as aluminum silicate not unlike talc. However, their analysis shows that pyrophyllite is unlike talc in having a 30 per cent content of free silica. Clinical and roentgenographic findings are similar to those that we report, but histopathologically, there is a difference in the tissue changes.

During the past ten years, one of us (J. R. P.) has noted that talc workers examined at chest clinics had diffuse pulmonary changes that were thought to be at least partly due to exposure to dust. Since the New York State Compensation Laws became effective about 1937, medical consultants of the New York State Department of Labor have rendered decisions that disability was produced in this industry. It is our understanding that this department has made surveys of the local talc mines and mills and will shortly report their findings. The 5 postmortem examinations included in this report are the observations of one of us (F. W. P.) and are, we believe, the first group available from which reasonable conclusions could be drawn as to the nature of the pneumoconiosis. The autopsy material was subsequently given to Dr. L. U. Gardner who will report his own findings, including chemical and petrological analysis, on these and other cases, and his deductions from a survey of one of the mines. None of our reported living cases are now working, and for that reason will not be included in a current survey of the industry.

Report of Cases

Case 1. A. S., aged forty-eight. Prior to 1920, this patient worked as a miner for three years in iron, two years in anthracite coal, and one year in feldspar. From 1920 until 1936 he was a driller in talc. He admitted excessive use of alcohol.

Admitted to St. John's Hospital, June 18, 1936, he complained of dyspnea, chest pain and cough with expectoration, all symptoms being then of several months' duration. Over the upper parts of both lungs there was impaired percussion resonance and there were scattered medium and fine râles. During a period of hospitalization of nearly three years there was no elevation of temperature. Examination of sputum was negative for tubercle bacilli until May 8, 1939. The course was slowly but steadily retrogressive and patient died July 27, 1939.

A chest roentgenogram made September 10, 1937, demonstrates heavily mottled increase in lung density throughout the entire right lung and in the left lung above the anterior level of the fifth rib. Conglomerate masses are present in the apices and in the median zones at the level of the hila. There is decreased density suggesting emphysema in the left lung field below the fifth rib level. Both leaves of the diaphragm are sharply tented. The trachea is deviated to the right. Subsequent films, to include that of December 1, 1938 (Fig. 1), show little change.

At autopsy there were found to be extensive intrapleural adhesions, dilated right ventricle, heavy bulky, non-collapsing lungs which on section showed everywhere extensive nodular fibrosis with internodular emphysematous areas. There was a single small cavity in the right apex. Some of the bronchi contained purulent fluid. Microscopically there were large fibrous hyalinized areas with similar smaller discrete nodes

sometimes connected by fibrous bands. Alveoli were greatly dilated. Both macrophages and asbestosis bodies were present in the alveoli and in the fibrohyalinized areas. There were a few caseous areas and scattered groups of leukocytes. The cause of death was determined to be extensive pulmonary fibrosis due to inhalation of dust. Chronic pulmonary tuberculosis was also found but was not extensive.

Anatomical Diagnosis: Diffuse fibrosing pneumoconiosis; silicosis; pulmonary emphysema; chronic pulmonary tuberculosis (slight); cor pulmonale; generalized passive congestion.

Case II. J. R., aged fifty-seven. During thirty four years of occupation as a miner, twenty-seven years were spent in talc. Seven years spent in lead and iron mines were prior to 1918. He finally stopped work during the autumn of 1932, having at that time been mine foreman for several years.

The patient first came under medical observation in the clinic on February 9, 1933, having at that time had shortness of breath, chest pain, dry cough and easy fatigability for about two years, increasing in severity. He had gained 15 pounds in body weight since stopping work five months previously. There were generally impaired pulmonary percussion resonance, medium râles of general distribution, and fine râles heard at the bases. At no time was the patient known to have fever, and examinations of sputum made frequently over a considerable interval were negative for tubercle bacilli. The clinical course was slowly retrogressive, and death occurred on June 6, 1939.

In the chest roentgenogram of February 9, 1933, there are indistinct fine nodules of variable size and density, having general distribution throughout the lung fields, and there is a diffuse generalized haziness, being less dense immediately above the domes of the diaphragm and in the left apex. The hila are large and dense, obscuring the heart borders. There are fine irregularities of the leaves of the diaphragm and blunting of the right costophrenic angle.

At autopsy clubbing of the fingers was noted and there was edema of the ankles and subcutaneous tissues of the trunk and legs. The right cardiac ventricle was moderately dilated and hypertrophied. Both lungs were heavy and firm with extensive fibrous pleural adhesions. On section many fibrous bands and firm, dark gray nodules were found throughout the lungs with pronounced emphysema of the remaining

Fig. 1. Case I. Pneumoconiosis (talc) with infection.

air bearing areas. In the upper areas there were small fields of old, apparently inactive fibroid tuberculosis. The lymph nodes were moderately enlarged, firm and on section were dark gray and glistening. Microscopically there were large fibrohyalinized areas within broad bands and areas of fibrosis containing fibroblasts, macrophages and some asbestosis bodies. There was extensive emphysema in the remaining alveoli. The lymph nodes contained fibrohyaline nodules.

Anatomical Diagnosis: Diffuse, fibrosing pneumoconiosis; silicosis; healed fibroid tuberculosis; cor pulmonale; generalized passive congestion.

Case III. J. B., aged fifty-two. Prior to 1920, this patient mined iron, sulphur and zinc over a total period of twelve years. From 1920, to May, 1936, he was a general utility man in a talc mine, most of which was not very dusty work. He operated a pneumatic drill from May to December, 1936.

Admitted to St. John's Hospital on January 4, 1937, he complained of shortness of breath of increasing severity over a period of two years, and of chest pain, and severe loss of weight for more than a year. He had had a moderately productive cough for six years. He appeared chronically ill, emaciated, obviously dyspneic. Medium and fine râles were heard over the entire chest and there were post-tussive râles over the right apex.

Fig. 2. Case iv. Early pneumoconiosis (talc) with intrapleural fluid collection.

In the chest roentgenogram of December 10, 1936, extending laterally from the right hilum into the median zone of the right lung field, below the anterior level of the third rib, there are coarse, poorly defined nodules of increased density, tending to become confluent. There is an indistinct reticulation throughout the remainder of the lung fields. The pleural reflection between the right upper and middle lobes is visualized. The left leaf of the diaphragm is peaked. At the level of the right fourth interspace, included in the area of dense confluent nodulation, there is a rounded area 3 cm. in diameter, having decreased density, suggesting cavitation.

During six weeks of hospitalization the patient usually had a slightly elevated temperature, and tubercle bacilli were found on the first and subsequent examinations of sputum. A clinical and roentgenographic diagnosis of fibroulcerative pulmonary tuberculosis was made with dust inhalation considered as a possible contributing factor. Against advice, the patient left the hospital February 13, 1937, and was not seen again prior to his death at home September 18, 1938.

At autopsy, except for a slight dilatation of the right ventricle, the only changes of importance were in the lungs. The right lung was heavy and bulky, weighing 1,400 grams, and was covered by thick fibrous adhesions. On section the parenchyma was generally firm, black and marked by thick fibrous bands. In the lower lobe there was a large irregular cavity with caseous borders and there were scattered caseous areas in other parts of the lung, particularly in the lower lobe. There were also scattered small firm black nodules throughout the lung, most of the air bearing tissue being at the apex. The left lung weighed 1,200 grams and had a smooth pleural surface and was generally air bearing. It was everywhere black and much firmer than normal due to heavy fibrous bands and small glistening black nodules. The hilar nodes were enlarged, firm, black and glistening and contained some fibrous areas and an occasional small area of caseation. Microscopically there were scattered large bands and areas of fibrosis.

Anatomical Diagnosis: Tuberculosilicosis; diffuse fibrosing pneumoconiosis.

Case iv. M. H., aged thirty-seven. From 1918 until January, 1939, this patient operated an elevator in the shaft of a talc mine, this being not very dusty work. From January, 1939, until he finally stopped work in June, 1940, he operated a pneumatic drill in a talc mine. He admitted alcoholic addiction.

He was first examined on July 13, 1939, complaining of shortness of breath, cough and easy fatigue of several weeks' duration. He was afebrile, had scattered musical râles and a chest expansion limited to 1 inch measured at nipple level. With medical advice, he continued to work. When seen again on May 23, 1940, the respiratory symptoms had become more severe and he had lost 8 pounds in body weight. He continued at work for another month, and on June 21, 1940, was admitted to the A. Barton Hepburn Hospital with an addition to his medical history of having recently passed bloody urine.

Urine was found to be sterile but constantly contained casts, blood cells and albumin. A urogram failed to show an excretory shadow. Urinary excretion estimated with phenolsulfonphthalein was 5 per cent in two hours and there was found to be 51 mg. of non-protein nitrogen and 36 mg. of urea nitrogen in 100 cc. of blood. Non-protein nitrogen retention increased to 78 mg. during September. All examinations of sputa were negative for tubercle bacilli. There was a constant but variable hypertension. Course was retrogressive and patient died October 20, 1940.

In the chest roentgenogram of September 17,

1940 (Fig. 2), there is an obliterated right costophrenic sinus, symmetrical haziness over the lower lung fields and some fine indistinct nodules in the peripheral zones above the anterior levels of the third ribs on both sides. The hila are slightly prominent.

At autopsy there was a little dependent edema of the tissues, especially of the ankles, and concentric hypertrophy and dilatation of the heart which had no valvular lesion and weighed 400 grams. The pleural surfaces were smooth with a little clear fluid in both pleural cavities. There was marked hypostatic congestion of the lungs which were moderately stiff, retaining their shape on section and revealing many grayish nodules of pin-head size generally distributed. The hilar nodes were moderately enlarged. The liver was enlarged, extending 3 cm. below the costal margin. The kidneys were normal in size but capsules stripped with difficulty, leaving granular pitted surfaces and the parenchyma was pale, mottled with cortical atrophy. Microscopically there were a few discrete widely scattered silicotic nodules in the lungs and in the hilar lymph nodes. In comparison there were several times the quantity of small cellular nodules and masses lying in the alveolar walls, perivascular and peribronchial spaces as well as about the silicotic nodules. In general, the nodules were small but surrounded all vessels seen in cross section. These nodules contained large phagocytic cells, fibroblasts, connective tissue fibers, occasional poorly formed giant cells and occasional small areas of necrosis. A definite but slight emphysema was present. Macrophages and occasional asbestosis bodies were present in some alveoli. In the hypostatic areas the changes were basically similar but with less numerous nodules and the alveoli filled with fluid, macrophages and erythrocytes. In one place there was a small area of suppuration involving a bronchial wall. In the kidneys there were the typical findings of chronic glomerulonephritis.

Anatomical Diagnosis: Chronic glomerulonephritis (hypertension); cardiac hypertrophy and dilatation, passive congestion of viscera. Slight diffuse fibrosing pneumoconiosis with some silicosis.

Case v. J. E., aged thirty-eight. During 1935–1936, this patient worked in a wet process (non-dusty) lead mine. From April, 1936, to May, 1937, he was in slightly dusty work as a dinky train engineer in an iron mine.

Fig. 3. Case v. February 1, 1940. Early pneumoconiosis (talc) manifested by diffuse haziness. The fine discrete nodules are due to healed infection and are only incidental.

He was a driller in talc from May, 1937, until April, 1941. He had pneumonia during 1938.

A chest roentgenogram of February 1, 1940 (Fig. 3), demonstrates fine discrete nodules of heavy density and nearly uniform size sparsely scattered throughout both lung fields below level of the third rib. There are large dense hila and lung fields above the anterior level of the fifth rib are diffusely hazy.

The patient sought medical consultation July 15, 1941, having in the previous eight months become short of breath, and lost 15 pounds in body weight. He was slightly cyanotic, fingers were markedly clubbed and scattered rhonchi were heard but no fine râles. The expiratory phase of respiration was prolonged. There was a sharply accentuated pulmonic second sound.

When admitted to the A. Barton Hepburn Hospital on August 25, 1941, he was severely dyspneic and had increased cyanosis. Repeated examinations of sputum, consisting only of thick tenacious mucus were negative for tubercle bacilli. Tuberculin test (PPD) was faintly positive only in the greater concentration (0.005 mg.). The red cell count and hemoglobin index were abnormally high. The course was retrogressive. There was no elevation of temperature prior to September 9, and the patient died September 12, 1941.

The chest roentgenogram of August 26, 1941

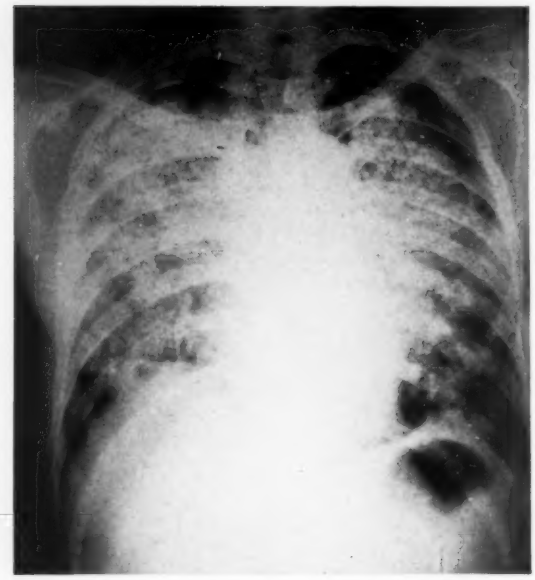

Fig. 4. Case v. August 26, 1941. Extensive rapidly developing pneumoconiosis with no active tuberculosis. Pneumothorax occurred spontaneously.

(Fig. 4), demonstrates a bilateral pneumothorax with very little collapse of the right lung and moderate collapse of the left upper. Throughout all of both lungs, except the costophrenic sinuses, there are finely mottled shadows of increased density generally confluent as to pattern, but in some peripheral fields appearing as poorly defined nodules of variable size. There is a diffuse general haziness and there are dense conglomerate masses in the parahilar and in the right subapical regions. The hila are large and dense and the heart borders are obscured. The trachea is deviated to the right; both leaves of the diaphragm are sharply peaked. The previously noted small discrete nodulation is seen only in areas having lesser generalized density.

At autopsy the skin was somewhat cyanotic. Examination of the heart revealed marked dilatation and hypertrophy of the right ventricle and slight dilatation of the left ventricle. Pneumothorax was present on the left. Both lungs were rather firm and heavy (weight, left—720 gm., right—820 gm.), being surrounded by extensive fibrous adhesions and covered by emphysematous blebs. In the parenchyma there were numerous diffusely scattered, poorly defined, firm gray areas of varying size interspersed with pronounced emphysema. There were also a few widely scattered calcified nodules about 4 mm. in diameter. The hilar lymph nodes were moderately enlarged containing firm gray areas and small pale hard nodules. Microscopically the lungs contained very extensive connecting bands composed chiefly of fibroblasts with a few connective tissue fibers. Many of the alveoli remaining were emphysematous; some were entirely enclosed in areas of fibrosis. Hyperplasia of the alveolar epithelium was in many places extensive enough to form small cell masses. Asbestosis bodies and macrophages were numerous in the smaller bronchioles, the alveoli and in the interstitial fibrotic areas. Poorly defined foreign body giant cells were found in some of the solid areas, but there were few leukocytes of any kind. In the centers of some of the solid masses there were small areas of necrosis but no definite tubercles. Specially stained sections were negative for acid fast bacilli or other bacteria. The lymph nodes had sinuses filled with reticulo-endothelial cells and contained a number of rather large fibrohyaline nodules, some with necrotic centers.

Anatomical Diagnosis: Diffuse fibrosing pneumoconiosis; pulmonary emphysema; pneumothorax left; cor pulmonale; generalized passive congestion. Diffuse miliary calcification (wheatena or aspergillosis).

Case vi. H. C., aged forty-eight. For six years immediately prior to admission to St. John's Hospital patient had worked as sweeper in a talc mill. His symptoms of dyspnea, slightly productive cough, loss of weight and strength and chest pain began insidiously two years previously and were moderately severe at time of admission. He appeared chronically ill and was obviously quite short of breath. There was a slight elevation of temperature. Fine râles were heard laterally near the bases of both lungs, and musical râles throughout the chest.

Roentgenogram of the chest dated October 29, 1931, demonstrates finely mottled increased density and diffuse haziness throughout the lung fields on both sides, denser on the right than on the left, denser in the lower lung fields than in the upper, partly obscuring the heart borders and the left leaf of the diaphragm, completely obscuring the right leaf of the diaphragm. There are no clear spaces of normal lung. Trachea is sharply deviated to the right. The clinical course was retrogressive, characterized chiefly by increasing dyspnea, and

death occurred in February, 1932. Diagnosis based upon occupational history and clinical and roentgenographic findings is pneumoconiosis.

Gross autopsy was done by Dr. J. E. Free. On examination of the lungs, Gardner[12] found nonspecific pneumoconiosis and tuberculosis but no evidence of silicosis.

Case vii. E. B., aged forty-two. During a period of fifteen years of mining, eleven years were spent in talc. Prior to 1927 he intermittently worked in lead and iron. From 1927 to 1931 he worked as a driller in a talc mine and since 1931 he has had no dusty occupation.

In the clinic on September 9, 1936, he gave a history of shortness of breath, chest pain, loss of weight and dry cough, all beginning insidiously about eight years previously. An acute cold ten days prior to admission had increased the severity of symptoms, causing expectoration of about an ounce of thick mucus per day. Scattered rhonchi but no moist râles were heard. Breath sounds were distant and friction sounds were heard at the bases. The fingers were clubbed. There was no elevation of temperature. When next seen, December 3, 1936, he was symptomatically improved and able to work. During a ten day period of hospitalization in September, 1937, the clinical findings were not significantly different, and he was entirely afebrile.

In the chest roentgenogram of September 24, 1936 (Fig. 5), there are conglomerate shadows in the parahilar region on both sides extending well into the peripheral zones throughout the remainder of the lungs. The three principal interlobar septa are seen as moderately thick lines. The leaves of the diaphragm are flat, irregular and indistinct. Heart borders are obscured but the heart is not enlarged.

Clinical Diagnosis: Pneumoconiosis (talc).

Case viii. W. D., aged forty-eight. Patient worked for sixteen years in talc mining usually as mucker or driller. One sister and one brother are thought to have died as the result of pulmonary tuberculosis.

When admitted to the County Tuberculosis Clinic, October 2, 1934, patient gave a history of gradual loss of weight aggregating 70 pounds, and of dyspnea, expectorant cough and repeated hemoptysis during the preceding eighteen months. Four years previously he had stopped work in the talc mines because of dyspnea and loss of physical endurance. He

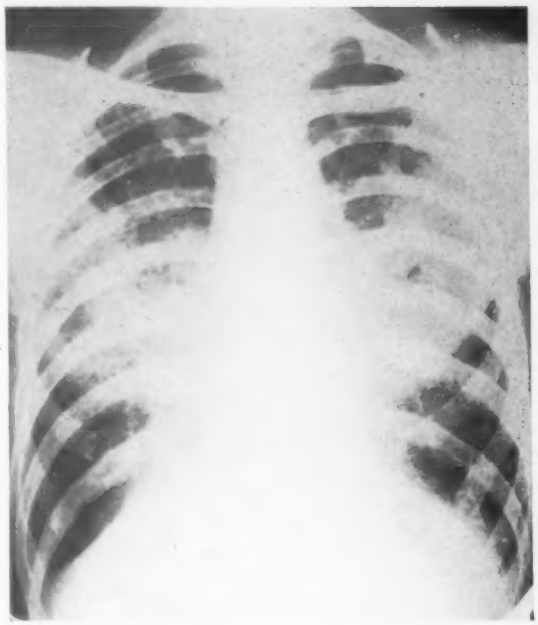

Fig. 5. Case vii. Pneumoconiosis (talc). The pattern of fibrosis is reticular with confluent lesions between the third and fifth rib levels.

was afebrile, had impaired pulmonary percussion resonance over the upper lobes, and medium moist post-tussive râles best heard in the third interspaces on both sides.

In the chest roentgenogram of November 3, 1932, indistinct nodules become confluent above the anterior levels of the third rib on the right and fourth rib on the left, forming coarsely mottled shadows extending to the periphery. In the right second interspace rounded areas of decreased density suggest multiple cavitation. Below the specified rib levels indistinct nodulation is less dense and more discrete. Trunk shadows are prominent and feathery. Leaves of the diaphragm are irregular and there appear to be calcified plaques over the domes of the diaphragm.

The patient died at home about a year after the examination above recorded. The clinical diagnosis was pulmonary tuberculosis. Attention is invited to the history of dusty occupation strictly limited to talc, to illness initiated by dyspnea, and to roentgenographic findings that are at least suggestive of pneumoconiosis. The only chest film was made at an intermediate time in the respiratory illness. It is believed that the diagnosis should have been "Pneumoconiosis (talc) with infection."

Fig. 6. Case x. Pneumoconiosis (talc). The lesion pattern is nodular.

Case ix. F. D., aged forty-six. Worked in talc mills or mines from 1912 until June, 1941, except for a three year interval during 1933 to 1935. All work was dusty but the period from June, 1939, to June, 1941, working as a sweeper in the mill, was very dusty. Two brothers and a sister died as the result of pulmonary disease.

He complained of loss of weight and strength and some shortness of breath. His usual body weight was 140 pounds. Before 1933 he had lost weight to 119 pounds, but during the following two years when he was not exposed to dust, and not doing heavy work, his weight became 153 pounds. He began to be a little short of breath and to lose weight again during the autumn of 1939. He has occasionally had a mildly productive cough, has not been at work since June, 1941, and during the intervening five months he has regained a little weight but is still short of breath. On December 7, 1941, patient appeared very poorly nourished and was slightly dyspneic and cyanotic. Body weight was 120 pounds, height 67 inches. Vital capacity was 2.3 liters (40 per cent below normal for his calculated surface area). Pulmonary percussion resonance was impaired over both apices. No râles or adventitious heart sounds were heard. Electrocardiogram December 7, 1941, was within the limits of normal. Tuberculin test was negative with an intradermal injection of 0.0015 mg. (PPD) but positive to 0.005 mg. (PPD).

Chest roentgenogram on May 4, 1939, shows that the lung fields above the first rib level on the right and first interspace level on the left are homogeneously opaque. Throughout the remainder of both lungs there is a fine indistinct reticulation of lines of slightly increased density. There is a well defined node 1.5 cm. in diameter in the median zone of the right lung field at the third rib level. The hila and trunk shadows are accentuated. There are plaque-like shadows having the density of calcium deposit over the domes of the diaphragm. The changes in a chest film made December 7, 1941, are an irregular deposit of calcium in the right lung field at the second interspace level and another in the left lung field at the second rib level; the trachea is slightly deviated to the right; the left costophrenic sulcus is obliterated by a homogeneous shadow having a lateral meniscus curve; there is an increased radiolucence of the right lower lung field. Roentgenoscopically observed the right hemidiaphragm has a respiratory excursion of 2 cm., the left is immobile.

Diagnosis: Pneumoconiosis (talc) with infection.

Case x. T. B., aged forty-five. This patient mined pyrites from 1918 until 1922 and worked as a driller and foreman in talc from 1923 to 1939.

In September, 1938, the patient began to be short of breath, to have chest pain and a slightly productive cough. These symptoms gradually increased in severity, he became physically weak and quitting work came under medical observation as a clinic patient in April, 1939. His symptoms were progressive until the autumn of 1940 and since that time there has been no change.

On April 10, 1940, there were pleural friction sounds at the bases of both lungs and medium moist râles over the apices. The fingers were markedly clubbed. There were no adventitious cardiac sounds. At no time during eighteen months of observation has elevation of temperature been noted at the clinic or reported by the patient. All examinations of sputa have been negative for tubercle bacilli. Tuberculin (PPD) intradermal reaction was positive December 10, 1941. Vital capacity was 2.1 liters (which is 52 per cent below normal for his height and

weight). Electrocardiogram is not abnormal.

Chest roentgenogram of May 11, 1939 (Fig. 6), shows fine nodular shadows of increased density and variable size, poorly defined, tending to become confluent, symmetrically distributed throughout both lung fields. The hila are large and dense. There is an overlying generalized haziness.

Diagnosis: Pneumoconiosis (talc).

Case xi. N. S., aged fifty-one. Usual occupation has been farming. During 1926 and 1927 and from October, 1938, to November, 1940, he worked as a mucker in a talc mine. During the winter of 1939 he gradually became short of breath and frequently dizzy. Non-productive cough and a feeling of tightness in the chest supervened. He became easily fatigued and had lost weight from 180 pounds to 148 pounds. He stopped work entirely and came under medical observation during November, 1940. During the succeeding ten months' period, there has been no appreciable change in symptomatology; he has regained 12 pounds in body weight.

On physical examination (October 10, 1941), there was increase in tactile fremitus and percussion resonance over the upper parts of both lungs. Medium râles were heard in the axillae and at both bases. There was a non-transmitted soft systolic apical murmur. Fingers and toes were markedly clubbed. Vital capacity was 2.8 liters (32 per cent below normal). Intradermal tuberculin test (0.0015 mg. PPD) was faintly positive. No elevation of temperature has been noted at any time, and examinations of sputum have been negative for tubercle bacilli. The electrocardiogram is within normal limits.

In the roentgenogram of October 2, 1941 (Fig. 7), there is a diffuse haziness over the left lung field below the anterior level of the fourth rib and a similar but somewhat less extensive area on the right. There is fine bronchovascular beading above the fourth rib levels on both sides. The left leaf of the diaphragm is not entirely smooth. The costophrenic sinuses and the right apex are comparatively clear.

Diagnosis: Pneumoconiosis (talc).

Case xii. R. P., aged thirty-two. This patient worked as a driller in a talc mine from December, 1936, to January, 1941. Chest roentgenogram made at the beginning of the period was reported as being normal. During December, 1940, although feeling quite well, a chest film was made at the patient's request

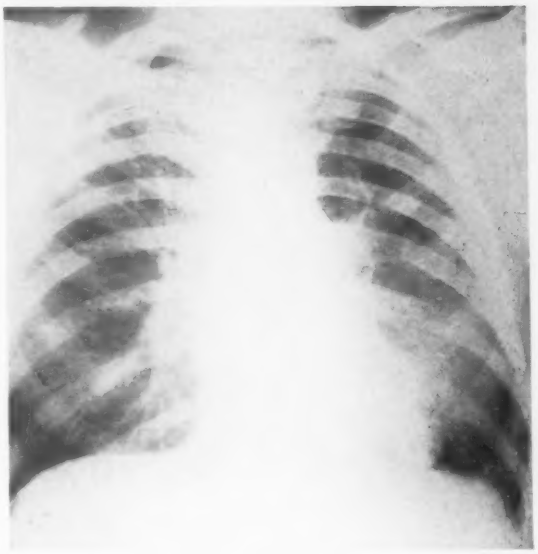

Fig. 7. Case xi. Rapidly developing pneumoconiosis (talc). Diffuse haziness.

and two weeks later he was advised that he had a little lung trouble, was taken out of the mine and given non-dusty work. A month later he was advised to go to a sanatorium.

Admitted to St. John's Hospital February 19, 1941, this patient did not appear ill. He was afebrile, had slightly impaired percussion resonance over the upper parts of the chest and there were a few scattered medium râles. During eight months of hospitalization he has continued to be afebrile, has had no cough and has gained 25 pounds in body weight. Only since August, 1941, has he observed that he becomes a little short of breath on walking a hundred yards rapidly. He is otherwise comfortable. All examinations of sputum have been negative for tubercle bacilli, and the content of the fasting stomach has likewise been negative both on direct smear and by animal inoculation. He had a positive tuberculin (patch) test. Vital capacity on November 15, 1941, was 2.2 liters, or 48 per cent below normal for his height and weight. Electrocardiographic tracing was essentially normal.

Chest film made in December, 1940, shows symmetrically distributed throughout both lungs between the anterior levels of the first and fourth ribs indistinct nodules of slightly increased density and variable size. The apices and spaces adjacent to the diaphragm are comparatively clear. Nodules are most confluent in the subapical regions. Hila are large and in-

Fig. 8. Case xii. Rapidly developing pneumoconiosis (talc), with subapical confluence of lesions.

distinct partly obscuring the heart borders. The trachea is slightly deviated to the right. The comparative chest film made October 13, 1941 (Fig. 8), shows a 2 cm. area of slightly decreased density in the median zone of the right lung field at the anterior level of the second rib with the surrounding area of confluent nodulation slightly denser and more homogeneous.

Diagnosis: Pneumoconiosis (talc).

Case xiii. I. S., aged forty-one. Worked as a driller in talc from 1917 to 1941. Had a non-dusty job operating an electric hoist above ground from 1925 to 1931 and from 1932 to 1941 was again in the mine as a foreman.

In June, 1940, the patient caught a severe cold obliging him to miss work for three days. Within a month thereafter he became short of breath, this symptom continuing with gradually increased severity. Since December, 1940, he has intermittently had a dry cough and prior to stopping work (June 2, 1941) he lost 10 pounds in body weight which was regained in the succeeding four months. He has not had fever.

On physical examination October 8, 1941, there was a greater respiratory excursion on the left than on the right, increased tactile fremitus anteriorly on both sides, generalized rhonchi and bronchial breathing over the left apex posteriorly. The mitral first and pulmonic second sounds were accentuated. Electrocardiogram was within normal limits. Vital capacity was 42 per cent below normal. Intradermal tuberculin test gave a positive reaction with 0.0015 mg. (PPD).

Since first coming under medical observation in May, 1941, he has had no apparent change except that his cough has become less severe. He has had no sputum suitable for examination.

In the chest film of May 18, 1941, there is generalized diffuse haziness heaviest in the regions of distribution of the lower lobe trunks. The right costophrenic sinus is least involved. In the peripheral zones there are numerous, poorly defined, usually discrete fine nodules. The trunk markings are obscure; the left leaf of the diaphragm is slightly irregular. No appreciable change is found in the roentgenogram of October 8, 1941.

Diagnosis: Pneumoconiosis (talc).

Case xiv. W. M., aged thirty-nine. From 1919 until 1921 he operated a dinky train in a pyrites mine. This was not dusty work. Began mining talc in 1922, working as a mucker for less than a year. Thereafter for twelve years he operated a pneumatic drill, then had charge of an "air shovel" for eighteen months, and finally worked as a driller again for a three year period ending in September, 1941. He has had no dust exposure since September, 1941.

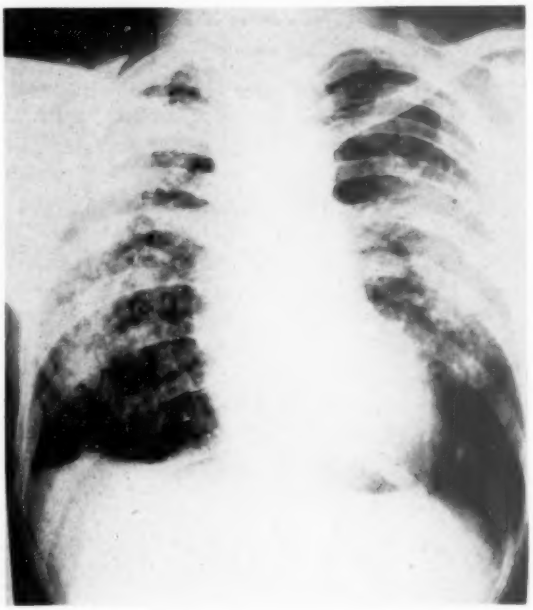

Fig. 9. Case xiv. Pneumoconiosis (talc). Peripheral confluence of lesions with lower lobe emphysema.

Family history is not significant except that his father also was a talc miner and died of pulmonary disease in 1932.

Patient has had shortness of breath of gradually increasing severity since June, 1941, and he has intermittently had a mild dry cough during the same period. He has had no fever, chest pain or loss of weight; has maintained his usual physical endurance except that because of shortness of breath he has been unable to perform the heavy lifting that pertains to his present work assignment.

On physical examination December 27, 1941, there was slight cyanosis and moderately clubbed fingers. Percussion resonance over the chest was generally diminished. No râles were heard except fine pleural râles over the lower thirds. Pulmonic first and mitral second sounds were accentuated. Vital capacity of 2.5 liters is 35 per cent below normal for his height and weight.

Roentgen examination of the chest, December 27, 1941 (Fig. 9), shows indistinct nodules of increased density and variable size closely spaced throughout both lung fields except the costophrenic sinuses and left apex. Nodulation is confluent in the median and peripheral zones of the right lung between the anterior levels of the first and fifth ribs. In the left lung lesions are confluent in the median and peripheral zones between the second and fifth rib levels. Below the fifth rib level there is an increased radiolucence suggesting emphysema. There is a prominent left hilum. The heart borders are indistinct. The leaves of the diaphragm are peaked, the costophrenic angles blunt. On roentgenoscopic examination the maximum respiratory excursion on each side is about 1 cm.

Diagnosis: Pneumoconiosis (talc).

Fig. 10. Case iv. Photomicrograph of lung illustrating perivascular lesions at *a* and peribronchial lesions at *b* (×45).

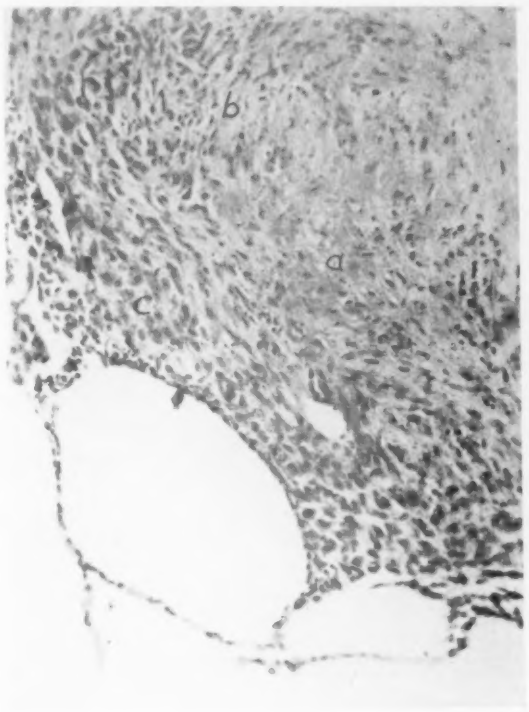

Fig. 11. Case iv. Pulmonary lesion illustrating necrosis at *a*, fibrosis at *b* and cellular reaction at . (×300).

Case xv. P. B., aged forty-five. For one year about 1923 the patient worked as a crusher in a talc mill. The only other dusty work was as a talc driller for a six year period ending in December, 1941.

During the past year he has had a mild cough with expectoration. He began to be short of breath and to have pain in the left lower chest during August, 1941. He has not had fever.

On December 27, 1941, he had slightly clubbed fingers, a maximum chest expansion of

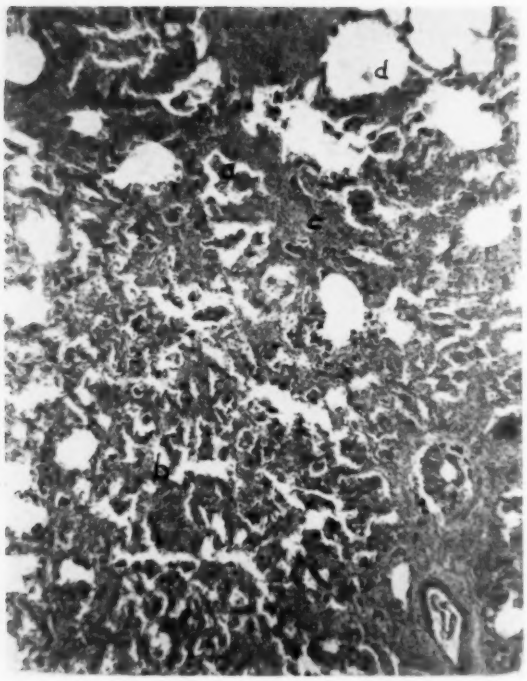

Fig. 12. Case v. General microscopic view showing macrophages in alveoli *a*, interstitial thickening *b*, fibrocellular nodule *c*, and emphysema *d* (×45).

1 inch, generally diminished percussion resonance and pleural râles over the lower thirds of both lungs. Mouth breathing was noted as being due to extreme deflection of the nasal septum.

In the chest roentgenogram of December 27, 1941, there are indefinite linear shadows of slightly increased density forming a fine symmetrical reticulation throughout the entire lung fields. In the peripheral zones there are occasional discrete, poorly defined nodules. The hila are prominent. The leaves of the diaphragm are slightly irregular. There is a visualized pleural reflection between the right upper and middle lobes.

Diagnosis: Pneumoconiosis (talc).

DISCUSSION

Occupational Exposure. In each of the cases described there is a history of exposure to talc dust chronologically related to the onset of symptoms. In 5 cases having had other dusty exposure, the intervening time between such exposure and the beginning of illness would indicate exposure to dust in the talc industry as the chief etiologic factor. It would appear from a consideration of Dreessen's analysis that the dust responsible for the disabling pneumoconiosis must be talc itself in the form of tremolite or soapstone or both since free silica was not found nor was other dust found in high concentration.

Symptomatology. Symptoms are those that are characteristic of disabling pneumoconiosis. Almost without exception they are dyspnea, cough, chest pain and weakness. Dyspnea has been the first and most distressing symptom in all except one case in which extensive tuberculosis was a complicating factor. Cough is either dry or productive of only small amounts of tenacious mucus. Cyanosis and clubbed fingers are seen. Except in cases having complicating tuberculosis, fever has been absent. In all cases tested with a spirometer, vital capacity was very low.

Pathology. The gross pulmonary changes common to all cases are stiffening of the lungs, poorly outlined grayish bands and

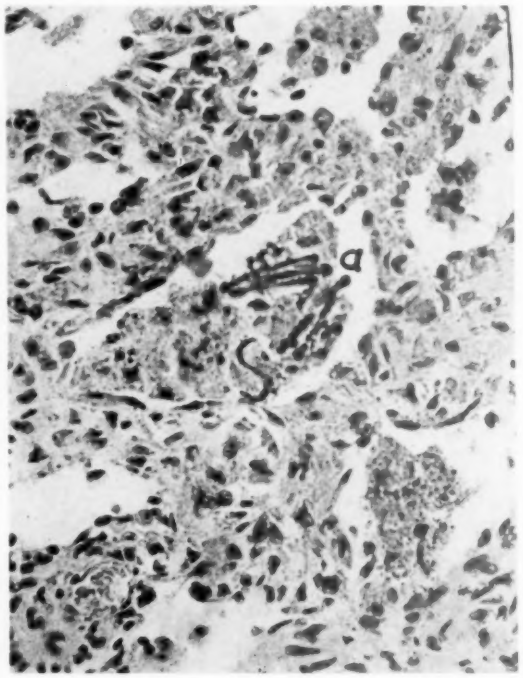

Fig. 13. Case v. Microscopic view of cellular reaction in alveoli, alveolar walls and alveolar débris including a group of asbestosis bodies at *a* (×300).

nodules appearing in parenchyma and moderate enlargement of the tracheobronchial lymph nodes. Compensatory emphysema is universally present but is not grossly recognized in the case with least involvement (Case IV). In the case with the greatest involvement (Case V), there are emphysematous bullae and cavities. In all except the least involved case, extensive intrapleural adhesions are found and in all advanced cases without important complication there is cor pulmonale. In the more slowly progressive advanced cases (Cases I, II and III), the lungs are darker and stiffer, and in the lung parenchyma and lymph nodes there are prominent fibrous bands and glistening nodules grossly similar to the massive conglomerate fibrosis described by Gardner.[10]

Microscopic changes consist chiefly of irregular areas and bands of cellular fibrosis surrounding the vessels and bronchi (Fig. 10), and producing thickening of the alveolar walls (Figs. 12 and 13). Histiocytes and fibroblasts are numerous in proportion to collagen fibers. Occasional poorly formed foreign body giant cells are present and dust laden macrophages lie in the alveoli. There are moderately numerous small indefinite areas of necrosis with surrounding fibrosis (Figs. 11 and 13). Where alveoli are occluded by fibrosis, there is hypertrophy of epithelium and occasional cell masses appearing not unlike carcinoma. An interesting finding common to all cases is moderately frequent presence of asbestosis bodies in the lesions (Fig. 13 and 14). Such bodies were first significantly described by Cooke and Hill[2] in a study of asbestosis. In the lungs of talc workers, they were first noted by Gardner[12] who recalled having seen them in the lungs of a talc worker autopsied prior to this series. The presence of asbestosis bodies in fibrotic areas implies a degree of similarity between asbestosis and pneumoconiosis due to talc. The chemical relation of the two dusts is apparent, both being silicates. Although the predominant particles in crushed talc are small crystals,

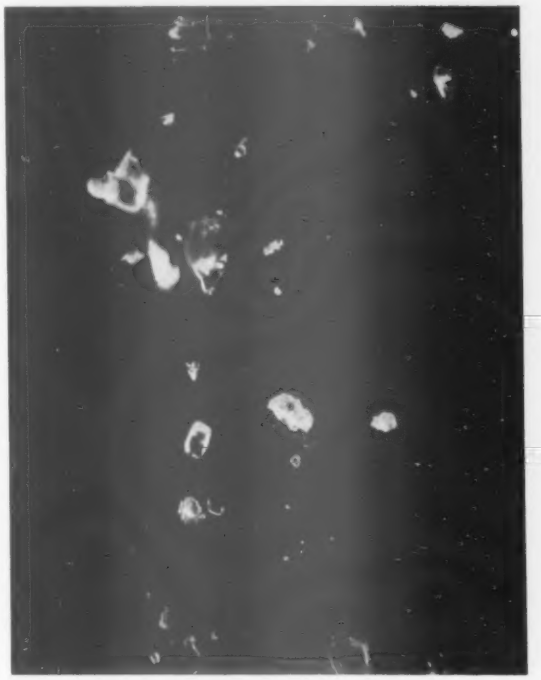

FIG. 15. Crushed granular talc. Dark field (×150).

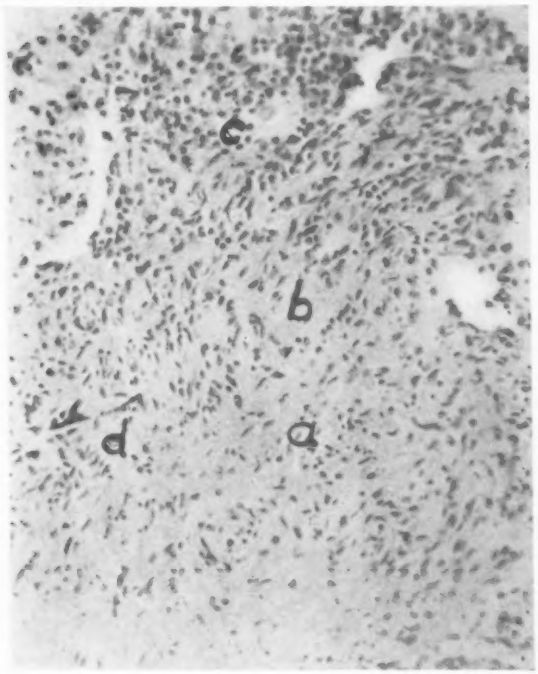

FIG. 14. Case V. Microscopic view of pulmonary lesion showing necrosis at *a*, fibrosis at *b*, cellular reaction at *c* and two asbestosis bodies at *d* (×150).

Fig. 16. Crushed soapstone talc.
Dark field (×150).

there are also crystalline spicules and fibers, the latter being longest and most numerous in the tremolite variety of local talc (Figs. 15, 16 and 17). It has yet to be determined whether all of the fibrosing effect of the silicates is due to the presence of fibers. Gardner[13] has shown that asbestos fibers ground to less than 3 microns in length produce less fibrosis in guinea pigs than longer fibers. However, it would appear probable from the observations of McNally and Trostler[15] and Dreessen and DallaValle,[6] that productive changes are not entirely accounted for by the presence of fibers, since they have not been reported as occurring in fullers' earth and are not very numerous in Georgia talc. Talc has also been noted to produce fibrosis in other tissues. It is being used by some cardiac surgeons to produce artificial pericardial adhesions and has been reported by McCormick and Ramsey[14] as having caused postoperative peritoneal adhesions.

Cases with extensive experience in other mining have confluent silicotic nodules in addition to the lesions described. In the slowly developing Case IV, without complicating chronic infection and with dust exposure only in the talc industry, only very occasional silicotic nodules are encountered in the lungs.

Theories as to the rapid development of Case V are that there may have been congenital or acquired individual susceptibility, complicating infection, overwhelming talc exposure, or heavy contamination of talc by free silica. There is no convincing clinical or histologic evidence of complicating infection or of extensive change definitely characteristic of silicosis. The microscopic massed nodulation found in rapidly progressive silicosis by Gardner[11] and Ritterhoff[20] is not found although occasional silicotic nodules are present in the lymph nodes. Chemical analysis will aid in determining the relative importance of free silica in such rapidly developing cases.

While tuberculosis or other complicating infection may be present, it should be emphasized that pneumoconiosis itself is a re-

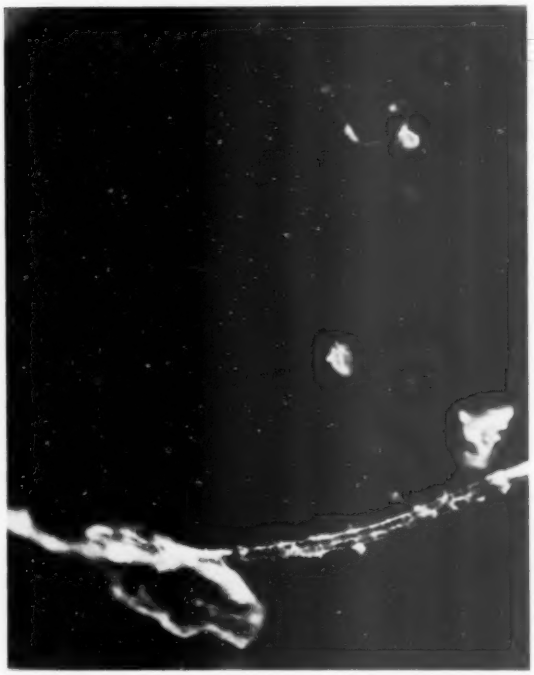

Fig. 17. Crushed tremolite talc.
Dark field (×150).

action to injury in living tissues by mobile cells and therefore an inflammatory disease with distinct resemblance to other chronic inflammation.

Roentgenographic Observations. Inasmuch as the abnormal roentgen shadows seen in early pneumoconiosis may be delicate, the technical factors used in making chest roentgenograms should have brief consideration. The equipment should be capable of producing teleroentgenographic films of diagnostic quality with a time factor not greater than one-tenth of a second. A 6 foot target film distance is desirable in order to reduce distortion; a short exposure time is necessary to eliminate loss of detail due to cardiac, vascular and respiratory motion. Satisfactory chest films are usually not obtained with portable equipment.

Within the limits of good diagnostic quality, some latitude is allowable in the matter of film density. We try to have exposure factors such that in a posteroanterior chest film the vertebral bodies are faintly shown through the cardiovascular shadow, the trachea is well defined and the skin, subcutaneous tissues and muscle planes tangent to the beam are identified. The density of the lung fields is not used as an index of film quality, inasmuch as it may be modified either by tissue changes or by exposure factors. The early changes of pneumoconiosis caused by fine interstitial fibrosis and emphysema are not seen in an overexposed or overpenetrated film.

Diffuse haziness is the most constantly noted roentgenographic abnormality and is probably the earliest change detectable in pneumoconiosis due to talc. A similar roentgenographic finding is characteristic of early asbestosis and was described by Pancoast and Pendergrass[18] as having been seen in a rapidly developing type of pneumoconiosis found in workers in granite and others. The lung field general background may be a fine indefinite reticulation of lines having density only slightly greater than normal lung fields. The appearance suggests that the diffuse haziness due to interstitial fibrosis has been modified by a fine emphysema. Another manifestation is nodulation. The nodules are less dense and less well defined than those of typical silicosis. They are variable as to size and tend to become confluent. The distribution is usually general but may be of greatest intensity in the parahilar or subapical regions or near the bases. Diffuse haziness, indefinite nodulation and reticulation may all be seen in the same film and appear to constitute the essential roentgenographic lesion patterns. They have been previously described by other authors as characteristic of other types of pneumoconiosis. Cole and Cole[3] give a descriptive name of "pock-marking type" of pneumoconiosis to fibrotic lesions appearing as reticulation.

While the finer lesions are typically general and symmetrical, the apices and costophrenic sinuses appear to be involved least and latest. Confluence of lesions and haziness usually begins in the areas of distribution of the lower lobe trunks. Confluent lesions in the upper lobes and near the base and in the peripheral zones may indicate a comparatively advanced stage, though extensive subapical confluent lesions are found in a case having only four years of exposure. Pendergrass,[19] after studying some of our films, observes that the distribution of lesions is unlike that of asbestosis in that in asbestosis productive lesions are found chiefly in the lower lung fields with emphysema involving the apices. The formation of conglomerate masses may be evidence of associated infection, but such a supposition has not received clinical or histologic confirmation from our observations. The shadows of the hila are often large and dense; the trunk lines may be prominent but are more often obscure.

One case, which at postmortem examination was found to have numerous subpleural blebs and extensive pleural adhesions, incurred spontaneous pneumothorax about a month prior to his death. The common occurrence of such an accident in silicosis has been noted by Moorman[17] and by Farrell, Sokoloff and Charr.[8] It appears that it would not be an unusual event in other

TABLE I

CLINICAL SUMMARY

Case Number	Years in Talc		Year Disabled	Employer	Dyspnea	Weakness	Chest Pain	Cough	Expectoration	Tubercle Bacilli in Sputum	Fever	Loss of Weight	Clubbed Fingers	Vital Capacity	Progress after Stopping Work
	A	B													
I	16		1936	Y	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	n.r.	n.r.	Death after three years of disability
II	27		1937	Y	Yes	Yes	Yes	Yes	No	No	No	No	Yes	n.r.	Death after three years of disability
III	1	17	1937	Y	Yes	n.r.	Yes	Yes	Yes	Yes	Yes	Yes	n.r.	n.r.	Death after one year of disability
IV	1	21	1939	Y	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	n.r.	Death after one year of disability*
V	5		1941	X	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	n.r.	Death after one year of disability
VI	6		1931	Y	Yes	n.r.	Yes	Yes	Yes	No	Yes	Yes	n.r.	n.r.	Death after two years of disability
VII	10		1937	X	Yes	n.r.	Yes	Yes	No	No	No	Yes	Yes	n.r.	Slowly increasing disability, 4 years
VIII	16		1934	Y	Yes	Yes	n.r.	Yes	Yes	No	No	Yes	n.r.	n.r.	Death after one year of disability
IX	26		1941	X	Yes	Yes	Yes	Yes	No	No	No	Yes	No	−40%	Partial disability; could do light work
X	16		1939	Y	Yes	Yes	Yes	Yes	No	No	No	No	Yes	−52%	Disabled. No change for two years
XI	4		1940	X	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	−32%	Disabled. No change
XII	4		1941	X	Yes	No	No	Yes	No	No	No	No	No	−48%	Increasing disability for one year
XIII	17	7	1941	Y	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	−42%	Disabled. No change

Table I—*Continued*

Case Number	Years in Talc		Year Disabled	Employer	Dyspnea	Weakness	Chest Pain	Cough	Expectoration	Tubercle Bacilli in Sputum	Fever	Loss of Weight	Clubbed Fingers	Vital Capacity	Progress after Stopping Work
	A	B													
XIV	20		1941	Y	Yes	No	No	Yes	No	No	No	No	Yes	−35%	Disabled. No change for three months
XV	7		1941	X	Yes	No	Yes	Yes	Yes	No	No	No	Yes	n.r.	Disabled for heavy work

A—Very dusty work. B—Moderately dusty work. n.r.—Not recorded.
* Death not attributed to pneumoconiosis.

types of pneumoconiosis.

Severity of symptoms appears to be more definitely related to the type rather than to the extent of the lesion seen roentgenographically. Moderately extensive coarse nodulation may cause only mild discomfort such as dyspnea after physical exertion. Fine diffuse haziness is more disabling.

Diagnosis. Diagnosis is made on the history of adequate exposure and on the roentgenographic findings. If disability is present the characteristic symptoms are significant. If uncomplicated, pneumoconiosis (talc) is so unlike the usual type of pulmonary tuberculosis in symptomatology and in the roentgenographic distribution of lesions as to make differential diagnosis comparatively easy.

It is important to properly evaluate tuberculosis complicating pneumoconiosis. Our observations would indicate that even where tuberculosis is established as a complicating factor, the principal cause of disability is often pneumoconiosis. Tuberculosis may contribute to the disability in pneumoconiosis and there are cases of chronic ulcerative pulmonary tuberculosis in which pneumoconiosis other than silicosis exists as an unimportant complication.

In uncomplicated pneumoconiosis (talc), the onset of symptoms marks the beginning of a degree of disability that appears to be irrecoverable. It seems desirable to withdraw the worker from exposure prior to that time. There are detectable roentgenographic changes before the onset of subjec-

Table II

AUTOPSY FINDINGS

Case No.	Years of Dust Exposure		Fibrous Pleural Adhesions	Diffuse Fibrosis	Asbestosis Bodies	Silicotic Nodules	Pulmonary Tuberculosis	Emphysema	Cor pulmonale
	Misc.	Talc							
I	6	16	++	+++	++	++	+	+++	+
II	7	27	++	+++	++	++	Slight	+++	+
III	12	18	++	++	++	++	+++	+++	o
IV	o	22	o	+	+	Occ.	o	+	o
V	2	5	++	+++	++	Occ.	o	+++	+

tive dyspnea or other symptoms. It is possible that vital capacity, having the advantage of being easily and cheaply determined, may be an effectual routine procedure in selecting workers that should be more thoroughly studied as potential subjects for withdrawal from exposure. Standard exercise tests for the objective determination of dyspnea may aid in the discovery of early pulmonary fibrosis. Such routine observations made periodically would constitute a degree of protection for both the worker and his employer. It seems that measures should also be instituted to reduce the dust concentrations.

SUMMARY

Literature pertaining to pneumoconiosis due to exposure to certain silicate dusts is reviewed.

Fifteen cases of pneumoconiosis in talc workers are reported including five autopsies. Disability or death is directly attributed to the pneumoconiosis in thirteen of the cases; pneumoconiosis is contributory to death in one, and incidental in the remaining case.

The nature of the dust, symptoms, pathology, roentgenographic findings, diagnosis, complications and prophylaxis are discussed.

CONCLUSIONS

1. Pneumoconiosis causing disability and death does occur in talc workers.

2. The disabling tissue changes are principally due to talc itself.

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CALCIFIED TUBERCULOMA OF THE BRAIN*

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CALCIFIED tuberculoma of the brain is rare. In a recent survey of the literature, Evans and Courville[4] were able to find but 15 reported instances including one which was unverified.[8] They added 3 cases of their own. However, we have been able to locate a report of one other verified case not included in their survey.[7] Another certified case not reported in full but briefly described by Paterson in a discussion of Dott and Levin's paper[3] has also been accepted, thus bringing to 19 the total number of verified intracranial calcified tuberculomas.

Scott and Graves,[14] in an earlier review, estimated that calcified tuberculoma represented about 0.01 per cent of all intracranial tuberculomas. It is possible, however, as Pancoast, Pendergrass and Schaeffer point out,[11] that calcified tuberculoma is more common than is supposed but that lack of routine skull studies on tuberculous patients does not allow a true estimation of their incidence.

While calcification in other types of intracranial tumors has received extensive treatment in the roentgen literature, very little has been written concerning the roentgen appearance of calcified tuberculoma, doubtless because it is so uncommon. Pancoast, Pendergrass and Schaeffer state regarding their roentgen diagnosis, . . . "that the appearance is not typical and that the identity of the shadow must be established, if at all, by correlation with the clinical data."‡ This cautious view is justified by the fact that of the 19 cases recorded, 10 were discovered at autopsy and 9 were an unsuspected finding at operation. In the 5 cases where preoperative roentgen examinations were made, the true nature of the calcified shadows was not recognized. Both Ström[17] and Sabat[13] have been credited by several writers with having made a correct roentgen diagnosis in their cases but a perusal of their original papers shows that they only described the appearance of the shadows. They did not make an etiologic diagnosis; the proper diagnosis was made by pathologic examination of the specimens.

Our interest in this subject was stimulated by encountering a case of calcified intracranial tuberculoma, the only one among a collection of more than 1,400 verified brain tumors. It is also, so far as we are able to find, unique, in that the diagnosis was suggested preoperatively upon the basis of the roentgen examination. The lesion was subsequently removed surgically and verified as a tuberculoma. The patient is alive and well at the time of writing, almost a year after operation.

Recent surgical experiences with intracranial tuberculomas, as reported in the cumulative statistics of the British Neurosurgical Society,[3] seem to indicate that with proper surgical methods and with careful selection of cases, it is possible to effect a cure in many instances. This renewed interest in the tuberculoma as a neurosurgical problem warrants their closer study particularly with regard to their roentgenographic aspect. In addition to the films of our own case, we have collected and reproduced the films of 6 cases from the literature in order to demonstrate both the similarities and differences in the appearance of the lesions. Two of the 6 cases are of post-

‡ Pancoast, Pendergrass and Schaeffer in their recent monograph (p. 643) state that there has been no verified case of calcified intracranial tuberculoma in the material of the Hospital of the University of Pennsylvania. The case reported here was verifiid after the completion of their manuscript.

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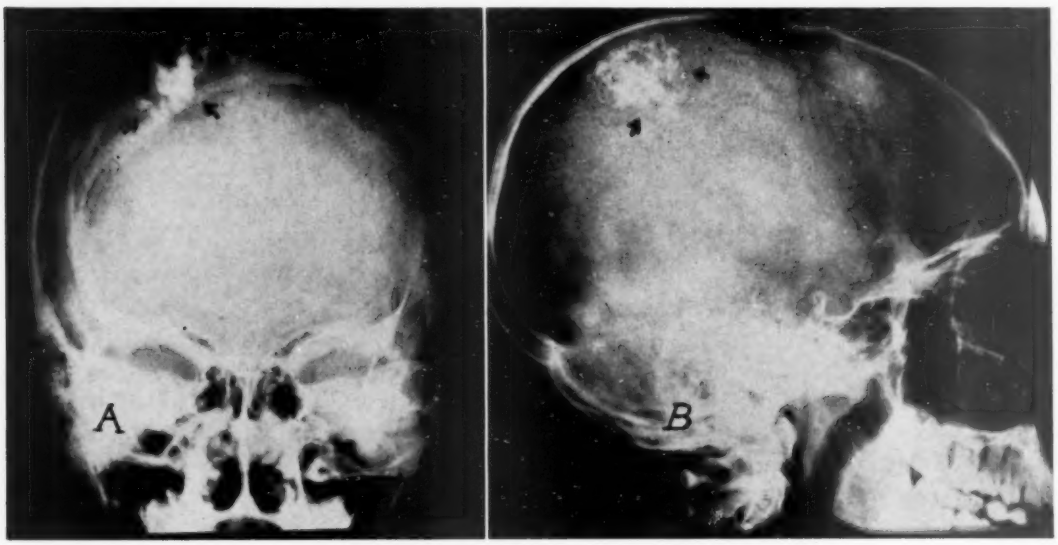

Fig. 1. *A*, anteroposterior and *B*, right lateral views of the skull. Mass indicated by arrows.

mortem specimens.[1,16] Although several of the reproductions are poor, one being altogether too poor to copy,[13] we have nevertheless reproduced those available for inspection.

CASE REPORT

L. S. (Surgical No. 44268). The patient, a colored boy, was first admitted to the Neurologic Service of Dr. Wm. B. Cadwalader, June 12, 1937, at the age of twelve, because of repeated convulsive attacks and weakness of the left extremities.

He had been normal until the age of five at which time he had his first attack. This was described as a "stiffening" of the entire body accompanied by unconsciousness. He "foamed at the mouth" and bit his tongue. This type of attack occurred frequently for a year and then changed in character, assuming a unilateral pattern, with clonic jactitations of the left extremities comprising the entire fit. The convulsions lasted five to fifteen minutes and were followed by transient weakness of the left extremities. These occurred several times weekly and as often as twice daily. When he was nine years old, it was noticed that he dragged his left leg and that the left extremities were not developing as well as the right. The disproportion between the size and length of the extremities became more pronounced as the child grew older.

The past history was not very informative. During infancy, he had an inflammation (?) of the left eye which left a film over it. Except for measles and whooping cough, he had none of the usual childhood diseases. There was no familial history of tuberculosis but because his parents were divorced, the child had been boarded in several foster homes and among family friends where he might well have been exposed to infection. He did poorly in school and had only reached the third grade although he should have been in the sixth.

Examination showed a cheerful but extremely restless, overactive and overtalkative colored boy. His mental development was unquestionably retarded and cooperation was difficult to obtain because of his marked restlessness. The general physical examination was essentially negative. Both of his left extremities were shorter and thinner than the right. The left leg was 2.5 cm. and the left arm 1.5 cm. shorter than the right. The left leg dragged on walking and because of the disproportion in length, he walked on his left toes. There was only slight loss of power in the left leg but the weakness was more evident in the arm. The tendon reflexes were hyperactive on the left but there were no pathological reflexes. All modalities of sensation were normal. Coordination was normal. The cranial nerves showed nothing remarkable. The fundi were normal. There was a small nebula on the right cornea.

The intraspinal pressure was within normal

limits. The cerebrospinal fluid contained no cells. The Wassermann reaction of both blood and spinal fluid was negative. Roentgen examination of the chest showed clear lung fields. There was a large calcified tracheobronchial lymph node in the hilum of the right lung which was thought probably to be caseous. The roentgen examination of the skull was described as follows by Dr. Philip J. Hodes of the Department of Roentgenology: "There is a spongy type of calcification in the right parieto-occipital region situated just beneath dura and well localized (Fig. 1). There is nothing characteristic in the appearance of the calcification. In view of the history extending over seven years, one must consider a relatively benign condition. The possibilities are hemangioma or an old hemorrhage. However, the possibility of a tuberculoma must also be considered."

The child was discharged but then followed periodically in the neurologic out-patient department.

He was readmitted to the Neurologic Service February 2, 1940, at which time he was fifteen years old. During the three year interval period his convulsive attacks had persisted but had again changed character. He now experienced an aura preceding the attack which consisted of a feeling of weakness in his left extremities. This was rapidly followed by a jerking in these extremities which lasted a few minutes and then terminated in a generalized convulsion with loss of consciousness. These major attacks were interspersed with frequent short "staring attacks." On rare occasions, he simply suddenly lost consciousness and fell to the ground without twitchings or jactitations.

On re-examination, it was found that his hyperactivity had increased to such an extent that he could hardly be examined and was almost unmanageable on the ward. He was silly, giggling, distractable and dull. The disparity between the lengths of his extremities was also more marked. The left leg was 3 cm. and the arm 2 cm. shorter than their mates. Motor power was still only slightly decreased in the left extremities but now a mild amount of spasticity could be demonstrated. A left Babinski sign was now present. Sensation was normal. Coordination was normal. The visual fields were full. Vision in the right eye was reduced to 6/12 owing to the nebula; vision in the left eye was normal. He was transferred to the Neurosurgical Department February 20, 1940.

Dr. Philip J. Hodes of the Department of Roentgenology in reviewing the case felt that in light of the history and the presence of the tracheobronchial lymph node, the lesion visualized on the skull was probably a calcified tuberculoma.[6] Because the convulsions were so severe and because it was thought that the tumor could be successfully attacked, operation was undertaken with this diagnosis in mind.

Operation. On February 27, 1940, under

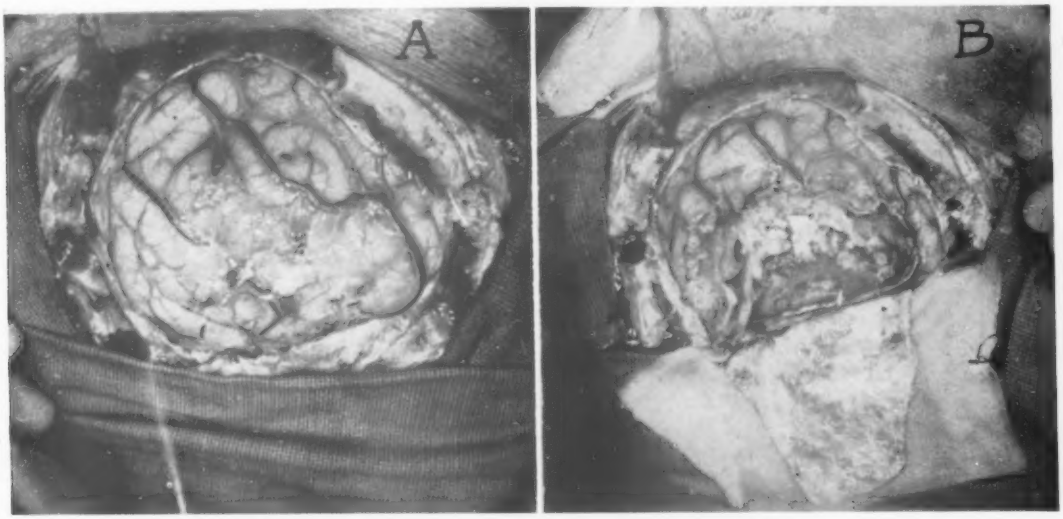

FIG. 2. *A*, surface appearance of the tuberculoma and surrounding brain. *B*, cavity remaining after removal of tuberculoma and contiguous brain substance. The relationship of the lesion to the falx can be easily seen since the dural flap is hinged along the longitudinal sinus.

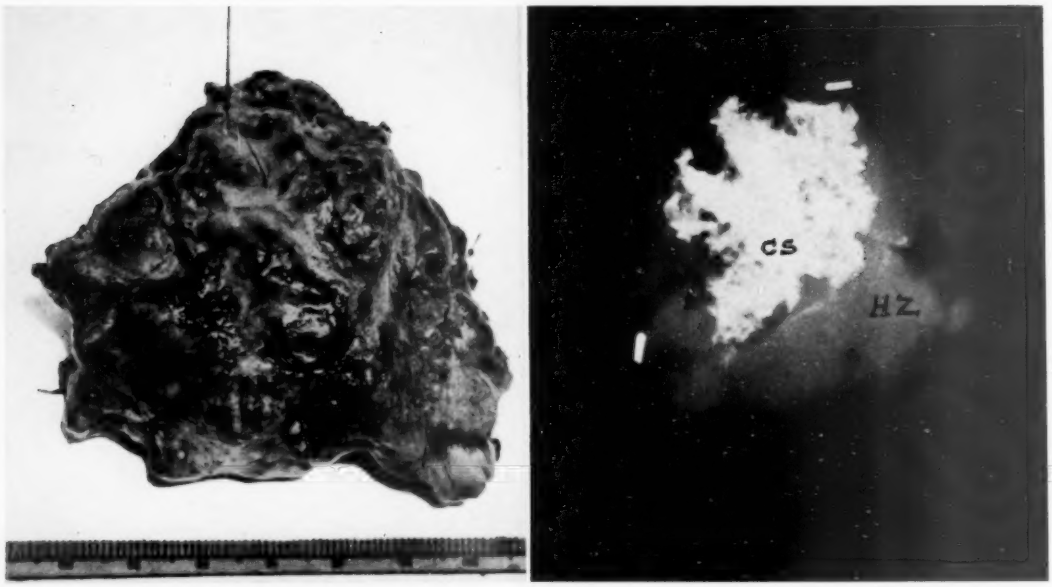

Fig. 3. The gross specimen as seen from its under side. In the roentgenogram, CS indicates the calcareous shell and HZ the hyalinized zone of connective tissue.

avertin anesthesia combined with local procaine infiltration of the scalp, a large parieto-occipital osteoplastic flap was reflected (L.M.W.) The flap was designed to cross the midline as the tumor was very near the longitudinal fissure. When the bone was reflected, a stony hard irregular mass could be palpated through the dura. The dura was opened but as it was tightly adherent to the underlying mass separation was tedious and difficult. High in the parietal lobe, adjacent to the falx, there was a large grayish, avascular mass that blended in with the surrounding cortex. It measured about 3×2 inches on the surface. As the illustration shows (Fig. 2 *A*) a large portion of the tumor seemed to be merely altered cortex. It was recognized that the mass represented a much larger granuloma than was indicated by the roentgen shadow. Block resection was undertaken which included at least a half-inch rim of apparently normal brain tissue. This was done to avoid any possible chance of causing dissemination of tubercle bacilli. Surgical experience has shown that this is the only safe and acceptable method of dealing with these lesions.[3] The mass extended 3.5 to 4.0 cm. beneath the surface of the brain and was adherent mesially to the falx from which it was separated with difficulty. Hemostasis was easily secured and the cavity (Fig. 2 *B*) filled with Ringer's solution. The dural flap was completely resutured in place and the wound closed.

Examination of Specimen. The appearance of the gross specimen and a roentgenogram of it are shown in Figure 3. It weighed 65 grams. It was so hard that it could not be cut through. Portions taken from the edge and decalcified showed on microscopic examination a typical conglomerate tuberculoma. There were areas of epithelioid cells containing large giant cells surrounded by a dense zone of collagenous and hyalinized connective tissue. The extent of the hyalinized connective tissue zone which surrounded the calcified areas is well shown in the roentgenogram of the specimen.

The child made an uneventful recovery and was out of bed on the eighth postoperative day. His gait was unaltered and the power in his left leg was the same as before operation but his left arm was paralyzed. In addition, postural sensation was lost in the left arm and there was a slight impairment of cutaneous sensibility over the entire left side of his body. The child was active and cheerful but more manageable than before operation. By the end of three months there was a moderate return of power in the left arm. He was having only an occassional mild attack. At present, ten months after operation, he is back in school attending an ungraded class.

PATHOLOGIC CONSIDERATION

Before describing the roentgen characteristics of the calcifications in intracranial tuberculoma, it is essential to give an account of the peculiar fashion in which calcium is deposited in these granulomas. From the investigations of Evans and Courville[4] it seems that there is great constancy in the manner in which this occurs. It follows that the roentgen picture should show marked similarity.

Intracranial tuberculomas are always hematogenous in origin and their very existence indicates a more or less successful effort of the brain tissues to heal the lesion and at the same time to isolate the healthy tissue from the bacilli or their products. A calcified tuberculoma represents the most successful effort in the direction of healing and all such lesions must necessarily be of great chronicity. Indeed, the histories of calcified tuberculomas range from four to sixty-one years.*

The pathogenesis of a calcified tuberculoma is briefly as follows: The development of a focus of caseation is accompanied by the proliferation of connective tissue about the periphery. This circumferential zone of granulation tissue may become very thick, and, in time, partly or wholly hyalinized. The formation of calcium, as Evans and Courville showed, occurs mainly in necrotic tissue, and it is deposited at the junction of the necrotic and connective tissue zones. The calcium is laid down as tiny crystals, calcospherites, which eventually coalesce and become confluent. Gradually the necrotic core is completely encased within a thin shell of calcium which in turn is surrounded by a wall of dense hyalinized or collagenous connective tissue. Over a great period of time the calcareous shell may also become quite thick and the necrotic core transformed into a crumbly chalk-like material. The thin calcareous shell subjected to the compression of the shrinking and contracting outer connective tissue zone is usually broken and fractured in some degree. The rupture of this shell may be minimal, as demonstrated by the reproduction of the cross section of the tuberculoma found at postmortem in Stewart's case[16] (Fig. 4 *A*). The illustration shows the central necrotic core enclosed by a calcareous shell, which though fairly well preserved, is nevertheless irregular, indented, and broken at the periphery. The irregularly broken calcareous shell is typical of calcified tuberculomas and does not occur in any other intracranial tumor.

Tuberculoma has a curious predilection for the cortex of the cerebrum or cerebellum. The reason for this is not known exactly, but is thought to be connected with the more abundant blood supply in the cortex. This fact is also important in the roentgen diagnosis of these lesions as will be pointed out in the following section.

ROENTGEN DIAGNOSIS

Based upon the pathogenesis and pathologic anatomy of the calcium structure in tuberculoma, one should anticipate certain appearances on roentgen examination. Several different, though closely similar appearances may exist, depending entirely upon the thickness of the calcareous shell and to what extent it has been fractured and crushed by the contraction of the external connective tissue wall.

With a perfectly preserved calcareous shell, if one may imagine that such a tuberculoma exists, the roentgen examination should show a dense homogeneous shadow spherical or spheroid in shape and approximately the same width in all diameters. However, such an appearance must be very rare if, indeed, it exists at all, since the calcareous shell is always deformed to some degree. In the instances where the contour is not greatly disturbed, the roentgen shadow will appear as a dense, somewhat irregular shadow with crenated, angular, or

* Lancereaux and Lackerbauer[9] reported the finding at autopsy of a calcified tuberculoma in the left thalamus of a woman sixty-five years old. She had a right hemiplegia since the age of four. Smith[15] records the case of a woman, aged sixty-two, who at autopsy was found to have a large firmly calcified tuberculoma in the right lenticular nucleus. The history obtained later showed that she had suffered a "stroke" at the age of four and a half years. She remained hemiplegic the remainder of her life. She was known always to have been dirty in her habits and eccentric.

indented margins. The diameters, assuming that the calcium shell is compressed equally from all points, will be roughly the same. Figure 4 *B*, which is a roentgenogram of the tuberculoma found in Stewart's case, illustrates this point. The roentgenogram, when compared with the gross specimen, shows how the deformity of the shell is re-

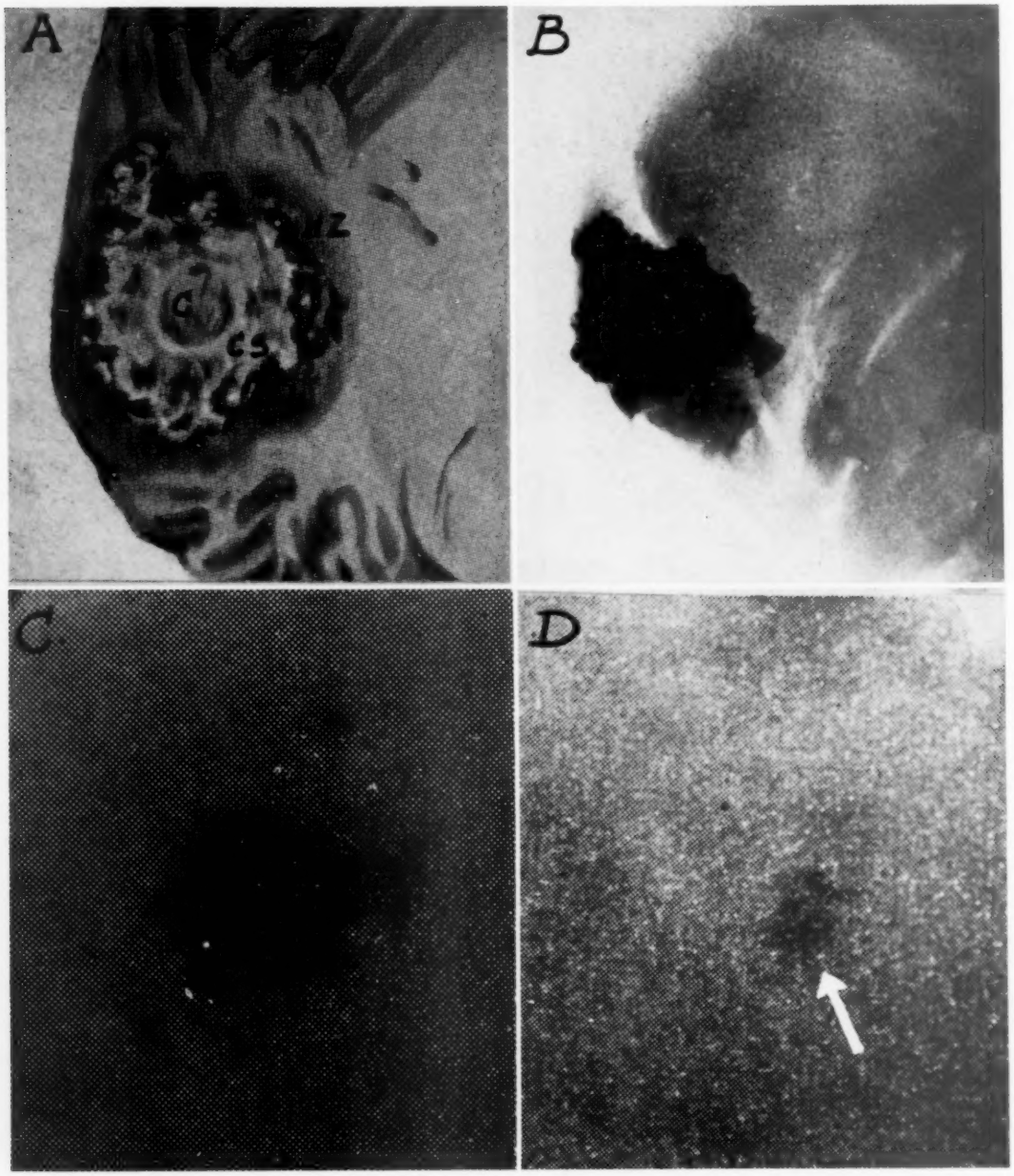

Fig. 4. *A*, reproduction of drawing from Stewart's case[16] of calcified cerebellar tuberculoma; C, the central core; CS, the calcareous shell; HZ, the hyalinized zone of connective issue. *B*, roentgenogram of Stewart's tuberculoma (*A*) made postmortem. *C*, roentgenogram of tuberculoma in Paterson and Stevenson's case.[12] *D*, roentgenogram of one of the tuberculomas in Borchardt's case.[1] Film made postmortem after placing brain in another skull. The views shown are only of the lesions. All are enlarged approximately 2×. The labelling is ours

flected in the roentgen appearance. Another example is the roentgenogram of the lesion in Paterson and Stevenson's case[12] reproduced in Figure 4 *C*. The author's description in Kingreen's case.[7] A fourth example is Borchardt's case[1] (Fig. 4 *D*) and a fifth is Sabat's case[13] whose roentgenograms could not be reproduced.

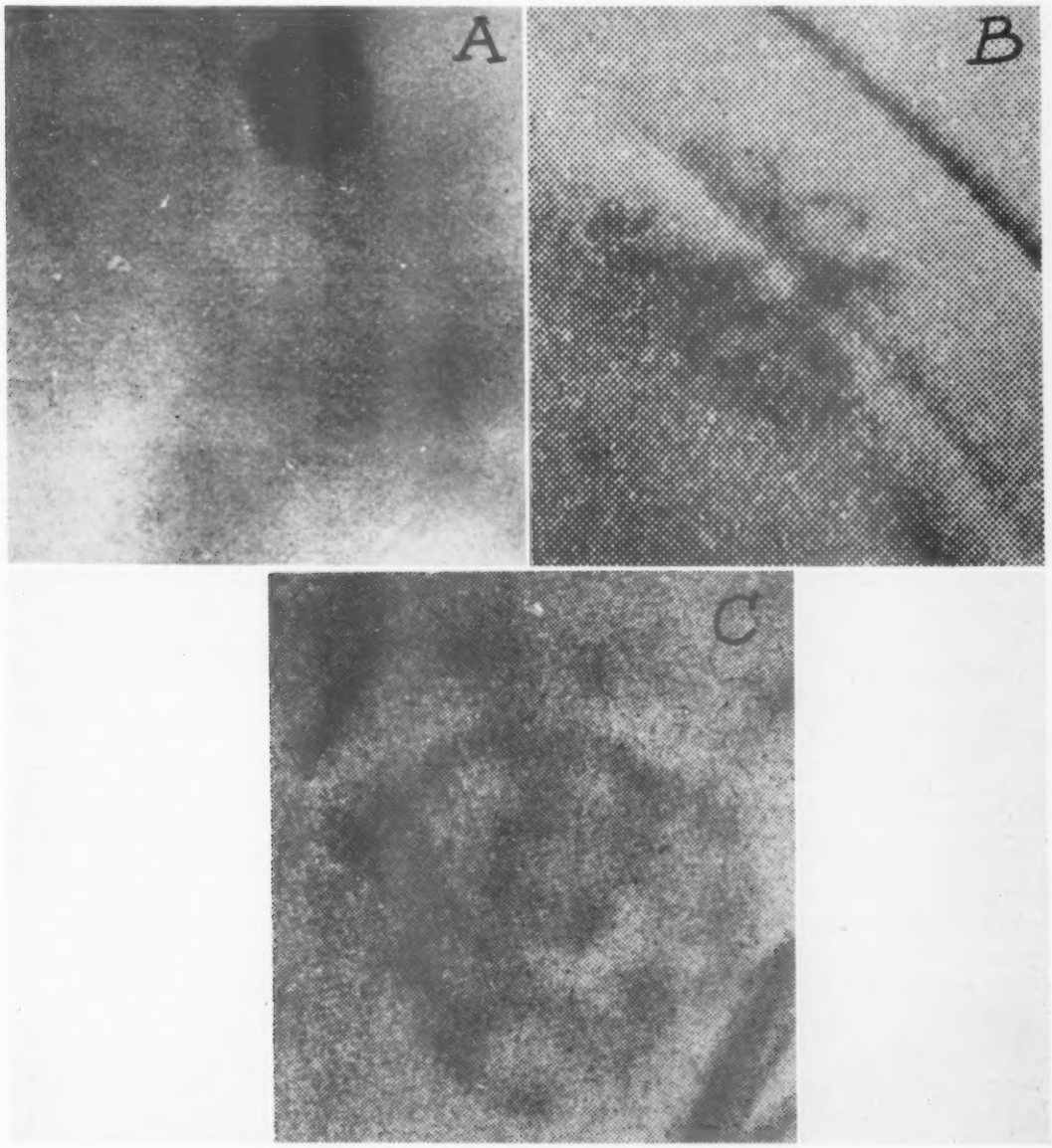

Fig. 5. *A*, parieto-occipital tuberculoma in Kingreen's case.[7] Enlarged 2× from reproduction. *B*, parieto-occipital tuberculoma in Vincent, Heuyer and Vogt's case.[18] Enlarged 4× from reproduction. *C*, basi-frontal tuberculoma in Ström's case.[17] Enlarged 3× from reproduction.

tion of the cut specimen is almost identical with that of Stewart's case. A similar shadow (Fig. 5 *A*) and a similar report on the appearance of the gross specimen are found

As indicated, the appearance of the roentgen shadow depends upon the degree of deformity of the calcareous shell. In some instances the periphery of the shell

may be badly shattered and crumbled and small pieces may be broken off. A roentgenogram in one plane will show an irregular dense shadow surrounded by a halo of spicules, small angular plates, trabeculae or tenuous strands. This appearance is well shown in the roentgenogram of the specimen from our own case (Fig. 3 *B*). A similar shadow occurs in the case of Vincent, Heuyer and Vogt[18] reproduced in Figure 5 *B*. The lateral view of this case which was, unfortunately, too poor for reproduction, shows this appearance even better. Even these rather badly fractured calcareous shells cast shadows which are approximately equal in all diameters. Though we have reproduced but one view from each case, the other views appearing in the original case reports support this observation.

The one example not accounted for by the patho-anatomic explanation offered is the case of Ström's,[17] the roentgen appearance of which is reproduced in Figure 5 *C*. The multiple interlacing circular shadows may represent calcification in the walls of a conglomerate tubercle composed of eight or nine separate tubercles. It is not similar to any other calcified tuberculoma previously reported.*

Since tuberculomas are commonly located in the cortex, the roentgen shadows of calcified tuberculoma are usually seen near the inner table of the skull. The distribution of the cerebral cortex over the mesial aspect of the hemispheres and over the basal gyri permit the occurrence of tuberculomas, however, far from the inner table. A midline or basal shadow may therefore be a tuberculoma. As a matter of fact, all but one of the cases of calcified tuberculoma previously reported with roentgen studies have been near the inner table of the calvarium.

While calcified tuberculomas usually occur singly, there are a few instances where two or three separate ones were visualized on roentgen examination[1,7] or found at autopsy.[4]

Though the peripheral zone of dense collagenous or hyalinized connective tissue may be quite thick, the calcified portions of tuberculomas are not large. The largest one is about the size of a walnut, the smallest, 2 or 3 mm. in diameter. It is hardly likely that the brain can cope with and isolate a tubercle larger than 2 or 3 cm. Larger ones which indicate either high bacillary virulence or poor tissue resistance probably always kill the patient and therefore obviously are never calcified.

DIFFERENTIAL DIAGNOSIS

Even though calcified tuberculomas appear to have fairly distinctive characteristics from the roentgenologic point of view, correlative data must, in some instances, be used to arrive at the proper diagnosis. For instance, a calcified hemorrhage or abscess may also produce a rounded dense shadow with slightly irregular borders.

When the clinical reports of calcified tuberculoma are reviewed, several features are repeatedly noted in the case histories.

The duration of symptoms is especially notable. Of the 13 cases where information was given on this point, the duration of symptoms ranged from four to sixty-one years, most of the cases having histories of five to fourteen years. Although the history of symptoms is long, the great majority of the reported cases have occurred in young people, usually before the age of twenty, and frequently under twelve.

In most of the cases in the literature there was little evidence of active systemic tuberculosis. This was especially true in those cases which came to operation. It is an interesting point, as Buchstein and Adson[2] point out, that intracranial tuberculoma in general tends to occur in persons who have but one extracranial focus of tuberculosis.

Very few of the cases exhibit signs of increased intracranial pressure since tuberculomas are necrotizing lesions rather than expanding ones. This is notably so in the case of calcified tuberculoma where the

* Although the lesion in Ström's case was reported by him as a tuberculoma and has been accepted as such by other writers, Ström was not able to prove the tuberculous nature of the tumor. It is possible, though we have no proof, that the lesion was some type of nonspecific granuloma with calcifications.

necrotizing activity of the bacilli has been largely or perhaps, in some cases, completely neutralized by the healing powers of the surrounding tissue. The absence of distortion of the surrounding brain can be seen in the reproduction of Stewart's case (Fig. 4 *A*) and in our own (Fig. 2 *A*).

Calcified tuberculoma tends to occur in the cerebral hemispheres although several cases of cerebellar or of both cerebral and cerebellar lesions have been recorded. Because of multiple infoldings of pia in the cerebellar folia, a tuberculoma of this organ is in contact with the leptomeninges at many points. Therefore tuberculomas of the cerebellum usually terminate in tuberculous meningitis rather early in their course and seldom exist long enough for calcification to occur.[2] Exceptions are the cases of Stewart,[16] Ogle,[10] Foà[5] and Kingreen.[7] Since the tuberculomas are lodged usually in the cortex, convulsions, generalized, but more often jacksonian, were observed in the reported cases. In all the cases which were operated upon, unilateral convulsions were noted at some time in the course of the disease and were commonly the initial symptom.

SUMMARY

A case of calcified intracranial tuberculoma is reported which was diagnosed by roentgen examination and subsequently removed surgically.

The pathogenesis of calcified tuberculoma is discussed and the characteristic pathologic anatomy of the lesions correlated with their roentgen appearance.

Roentgenograms of the other cases recorded in the literature are reproduced for comparison.

The clinical data on calcified intracranial tuberculoma are analyzed for the purpose of differential diagnosis.

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THE ROENTGENOLOGIC DIAGNOSIS OF TUMORS OF BONE*

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THE roentgenologic examination is a most important factor in the diagnosis of tumors involving bone. It has long been the practice in the Mayo Clinic to have a primary roentgenographic examination made on the part in which there is a suspicion of the occurrence of a tumor of bone. A diagnosis is made on the basis of the characteristics of the roentgenographic image. The roentgenographic report is correlated with the facts deduced from the history obtainable from the patient, relatives or other interested persons, and from the results of all other laboratory examinations. If factors in the report are not in agreement with all other findings, a consultation is arranged in which the roentgenologist has the privilege of learning all the facts elicited during all other examinations and of reviewing the roentgenograms or of re-examining the patient with the aid of this added knowledge. This arrangement has proved most satisfactory in the study of this type of lesion.

Because roentgenology affords a graphic illustration of normal and abnormal growth in the living person, in the experience of those with adequate knowledge and training, roentgenologic diagnosis has attained a high degree of accuracy.

With the accumulation of graphic illustrations of various forms of abnormality in many publications, it has been possible to establish pathognomonic features by which many types of morbid processes involving bone may be classified. It is my purpose briefly to outline these features in order of their importance and thereby establish a foundation on which a thoroughly sound diagnostic structure can be erected.

The roentgenologist has justified his position in the diagnostic group the moment he has demonstrated the presence of a lesion in the bone. The next decision very important to the interests of the patient is that of the nature of the lesion present. Is it an inflammatory one or is it the result of involvement by a tumor? Of still greater importance is the decision as to whether the tumor is benign or malignant in nature. This latter decision can be made with a high degree of accuracy by the roentgenologist.

The benign tumor involving bone exemplifies in its roentgenographic image the classic description of the benign tumor given by the pathologist; it is an aberration of normal growth in which the inhibitory factor which normally controls the architecture of tissues is partially suspended but is not lost. When this inhibition is completely eliminated, the malignant tumor results.

In the roentgenographic image of the benign tumor involving bone the continuity of the cortical contour is always intact. In the shadow of the bone involved there is a change in the density; the bone may be more translucent in the involved portion or it may be more dense than that characteristic of normal bone, depending on the nature of the tumor. Bone is destroyed by pressure erosion as a result of growth of the tumor; the margin of the tumor is definite and smooth and can be distinguished from that of the normal bone. When in its growth the benign tumor expands the cortex of the bone, it may markedly alter the continuity of the cortical contour, but it never breaks that continuity. In its development the shadow of the tumor will invade the contiguous soft tissue structures. The outline of the invasion shadow is definitely demarcated from the shadow of the soft tissue structures. This definite demarcation from

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surrounding shadows and the maintenance of the continuity of the cortical contour constitute the keystone in the diagnosis of this type of tumor.

When all natural control of growth is abated, the tumor runs wild and is then designated as a "malignant" tumor. This characteristic is best exemplified in the osteogenic malignant tumor now classified as "osteogenic sarcoma." The adjective "osteogenic" does not signify literally that the tumor is bone forming; the term was adopted to indicate that the tumor had its origin in bone cells, to distinguish it from tumors which originate in cells of bone marrow or in the vessels of bone or marrow. The malignant nature of the osteogenic sarcoma is exemplified in the roentgenogram by the sudden dissolution of the cortical contour at one point in the bone (the last remnant of control is exemplified in the small wave of periosteum elevated from the underlying cortex just above the break in the contour), the denuding of the cortex from the underlying bone below the break and the "promiscuous" nature of the invasion shadow when the tumor extends, as it usually does, into the surrounding soft tissue structures. The margin of the invasion shadow fades imperceptibly into that of the soft tissue structures. The same feature is seen in the bone itself. The margins of the filling defect in the bone caused by the tumor involvement are irregular, serrated or fade imperceptibly into the shadow of the normal bone.

In the most important phases, therefore, of the diagnosis of lesions of bone and particularly of tumors involving bone, the roentgenographic method is the outstandingly accurate and at the same time the most rapid and most convenient of all diagnostic methods. It furnishes the clue and materially facilitates narrowing of the investigation to limited fields.

From this point onward all information afforded is of secondary importance, but much of it may be useful in the decision as to the proper therapeutic measures to be employed in the individual case. With the accumulation of large groups of examples of the roentgenographic image of various forms of tumors of bone, it has been possible to recognize characteristic features by means of which these tumors may be classified and distinguished by the roentgenographic method.

BENIGN TUMORS OF BONE

Osteogenic Tumors. The greater number of benign tumors of bone can be classified properly as being osteogenic. Careful study of the clinical notes taken during elicitation of the history and the data regarding the incidence by age, specificity of situation and cessation of growth at or shortly after the period at which maturity of growth is attained lead to the conclusion that these tumors are the result of congenital aberrations of normal development, the most feasible explanation being a congenital defect in the periosteum, the function of which seems to be control of the architecture of bone. This theory is sustained by the experience that the growth of these tumors is perceptibly hastened by the occurrence of pathologic fracture. It is also an established fact that subsequent to any type of surgical intervention these tumors are very likely to recur and to grow much more rapidly in recurrence. Discovery of an evident mutation of the cell which has resulted in production of a chondrosarcoma is a comparatively common occurrence.

The clinical experience gained from roentgenographic studies of this group of tumors would suggest that there should be no attempt at surgical intervention until at least after maturity of growth of the patient concerned has been attained. When mechanical interference, fracture or some other occurrence suggests or demands surgical intervention, only resection of a wide portion of bone on both sides of the origin of the tumor (which would include the tumor) offers protection against recurrence and the development of chondrosarcoma. Because these lesions are aberrations of normal growth, radiotherapy obviously has no value in the treatment of such tumors.

Nonosteogenic Tumors. Nonosteogenic benign tumors of bone are encountered comparatively rarely. Hemangioma may occur in the bones of the extremities. The characteristic roentgenographic image shows an expansion of the cortex extending centripetally. It has been aptly described as producing a "soap-bubble effect" under the distended cortex of the bone. Hemangioma is encountered more frequently involving the body of one or more vertebrae than in other regions. The background of the bone shadow becomes more translucent and has superimposed on it the exaggerated shadows of the trabecular elements of the bone vertically disposed, producing a striated appearance in the bone. Pathologic fracture of the vertebral body involved is comparatively frequently observed.

Benign giant-cell tumor and osteodystrophia fibrosa cystica in the localized form result from some aberration in normal reparative processes. Simple cysts in bone can be placed in the same category. These are all granulomas of bone. The accepted theory of their origin is that some trauma, more or less severe, has occurred in which hemorrhage into the substance of the bone took place. The trauma was not sufficient to inhibit function. Continued function of the involved part resulted in secondary hemorrhage with aberration of the normal healing process.

Giant-cell tumor exhibits a specificity of situation in the epiphysis of the long bones, in contradistinction to the majority of osteogenic benign and malignant tumors, which tend to occur in the metaphyseal portion of the bone, which is the growing portion of the bone of the shaft immediately adjacent to the epiphyseal line. Giant cell tumor has its origin under the periosteum, and expands centrifugally in its growth. It frequently crosses the central line and markedly expands the cortex on the opposite side of the bone from that in which it had its origin. In its early stages the tumor has a characteristic roentgenologic image. The background of the bone shadow is more translucent than is that of the normal bone and it is criss-crossed with a series of opaque lines which represent the trabeculae of the bone. As the tumor grows, the opaque shadows disappear; the whole tumor area assumes a "ground-glass" appearance. The cortex may be markedly distended and the contour of the cortex thinned to a point at which it no longer is discernible in the roentgenogram. Brilliant illumination of the soft tissue region (achieved by holding the roentgenogram in front of a concentrated light) may be necessary at this stage to permit visualization of the outline of the invasion shadow and determination of its continuity. Without this careful inspection a giant-cell tumor in its advanced stages might easily be erroneously interpreted as being a malignant tumor. Giant-cell tumor responds favorably to adequate radiotherapy. Surgical intervention may be required to obviate the possibility of pathologic fracture. In the treatment of this condition, as in the treatment of the osteogenic benign tumor, resection of a segment of the bone, including the tumor, and interposition of a bone graft is the best surgical procedure.

Simple cysts and osteodystrophia fibrosa cystica (osteitis) in the localized form have an etiology similar to that described for giant-cell tumor. The majority of the lesions probably occur during the early life of the patients and have their origin in the metaphyseal portion of the bone. They are probably latent for a long period. Some are carried by the growth of the bone well up into the diaphyseal portion of the bone. This probably accounts for those tumors which involve the shafts of bones. Cysts and osteodystrophia fibrosa cystica, evidently because of their comparative chronicity, do not respond favorably to radiotherapy. They may require surgical intervention to obviate pathologic fracture.

Traumatic osteoma is a portion of ossification in the tissues other than bone, most frequently muscles, which occurs after trauma and laceration. Clinically, this type of lesion has many of the characteristics of tumor, and roentgenographically it must be

distinguished from tumor involving bone. The most frequently observed example is the ossified subperiosteal hematoma. The intact form may simulate an osteogenic benign tumor (osteoma) but can be distinguished by its situation (usually in the midshaft), the limited involvement and localized elevation of the periosteum on one aspect of the shaft only. The ruptured form results in the appearance of long, coarse strands of bone tissue which run vertically in the soft tissues and parallel to the shaft of the bone. These have a characteristic appearance that should not be mistaken for any form of benign or malignant tumor involving bone. A form of traumatic osteoma commonly referred to as "rider's bone" is a true form of myositis ossificans. It is of interest to note that this condition is practically never encountered among experienced riders. It is usually the result of one definite episode of trauma or prolonged riding by inexperienced persons.

Fibrositis ossificans progressiva is a hereditary condition with a most discouraging prognosis. It is often erroneously referred to as "myositis ossificans."

MALIGNANT TUMORS OF BONE

Tumors Which Simulate Benign Tumors of Bone. Myeloma in its roentgenographic features has all the characteristics of the benign tumor. It may expand the cortex of the long bone or the flat bone to a marked degree, but it never causes any break in the continuity of the contour. It may simulate the benign giant-cell tumor in its roentgenographic image, but the trabeculations are much coarser and are more widely spaced than are those of the benign giant-cell tumor. When the cortex of the bone is not altered, the filling defects in the bone shadow are smooth margined and discrete; they have the appearance of having been made with the aid of a steel punch. General involvement often exhibits more or less complete destruction of one or more vertebral bodies. Myeloma under such circumstances may be difficult to distinguish from metastatic malignant involvement of bone. Roentgenologic examination of the cranial vault will show best the typical filling defects in the bone shadow; in metastatic malignant involvement the margins of the filling defect will be irregular or will fade imperceptibly into the shadow of the normal bone. Myeloma does not respond favorably to radiotherapy.

Periosteal fibrosarcoma (extraperiosteal sarcoma) frequently erodes bone by pressure. In such cases, the filling defect in the bone will be smooth margined and the cortex will show no evidence of dissolution of the cortical contour.

Malignant Tumors Proper. The pathognomonic features of the malignant tumor of bone as they appear in osteogenic sarcoma have been described.

The most commonly observed nonosteogenic tumor involving bone is Ewing's endothelioma (hemangio-endothelioma or Ewing's sarcoma). This tumor roentgenologically may not exhibit the characteristic dissolution of continuity of the cortical contour. It may be characterized by an elliptic expansion of the periosteum of the shaft of a long bone. The periosteum may appear as a series of laminas which give it what has been termed an "onion skin" character. When the tumor does break through the cortex, abrupt dissolution of the continuity of the contour occurs. The laminated appearance of the cortex with break in the continuity of the contour may occur simultaneously. In the denuded region short spicules of bone extending at right angles to the shaft may appear. When the tumor invades the contiguous soft tissue structures, the margins of the invading shadow are not so well demarcated as are those of the benign tumor, yet they are faintly discernible in contradistinction to the promiscuously invasive character of those of the osteogenic sarcoma. Ewing's tumor responds favorably to radiotherapy and this fact is made use of for diagnostic purposes. Under adequate treatment, marked ossification occurs subperiosteally and the periosteal shell becomes thickened and sclerotic, producing much the appear-

ance of the involucrum which occurs in osteomyelitis with healing. In its clinical and roentgenographic aspects, Ewing's tumor simulates osteomyelitis very closely and most frequently has to be distinguished from pyogenic infection of bone.

Malignant angioma involving bone is rarely observed. Roentgenographically it presents a bizarre image of widely distributed, coarse strands of bone extending at more or less right angles to the shaft of the bone. Osteogenic sarcoma involving the middle portions of the shafts of long bones presents a similar but less widely distributed series of coarse spicules. All these tumors respond less favorably to radiotherapy than does Ewing's tumor. Roentgenographically, typical Ewing's tumor involving the middle third portion of the shaft of the femur have proved by biopsy and by their response to radiotherapy to be osteogenic sarcoma.

Metastatic carcinoma (secondary) may be localized or may cause general involvement of nearly all the bone structures. In its localized form metastatic carcinoma may present the most typical roentgenographic image of involvement of bone by a malignant tumor. If the bone is visualized as being formed of ice, metastatic carcinoma completely "melts out" a section of the bone. An embolus is formed by a small mass of tissue which has become separated from a tumor in some part distant from bone and carried through lymph and blood channels to a site in the bone at which conditions are favorable for its development into a tumor which has all the characteristics of the parent tumor. As the tumor develops, it causes destruction of the bone. The process is almost entirely osteolytic. There is little or no evidence of the occurrence of a defensive reaction in the bone itself. The tumefaction seldom invades contiguous soft tissue structures. The typical roentgenographic image is an abrupt dissolution of the continuity of the cortical contour with an increased translucency of the bone shadow in the involved region. Experience has shown that the tendency toward secondary involvement of bone is proportionate to the degree of malignancy of the primary tumor. The most virulent tumors metastasize most frequently.

In the less virulent and more slowly growing tumors there is a tendency toward reabsorption of calcium in the decalcified involved portions with varying degrees of increased density resulting. This probably is associated with glandular involvement, which causes pressure on the vessels concerned with the supply of arterial blood to the bone. The gradual diminution of the volume of arterial blood available to the involved part is known to stimulate this reabsorption of calcium, with the resultant formation of an osteoid form of tissue in inflammatory diseases involving bone. There is every reason to believe that such diminution in the volume of the supply of arterial blood is the etiologic factor in the production of the osteoplastic (sclerotic) forms of metastasis to bone. These forms are encountered most frequently as being secondary to carcinoma of the prostate gland and only occasionally as being secondary to scirrhous carcinoma of the breast and the stomach.

Demonstration of the presence of metastatic carcinoma by roentgenographic examination frequently proves to be the first evidence of the existence of the primary tumor. Roentgenographic discovery leads to investigation with the purpose of elicitation of information that will identify the site of this primary malignant tumor. Biopsy of tissue from the metastatic tumor frequently will furnish this information. In cases of general involvement there may be some difficulty in distinction between metastasis to bone and multiple myeloma. The vacuolated appearance of the individual filling defects in the bone in the presence of myeloma is characteristic. In the vertebral bodies and in the bones of the pelvis these are not so often easily discernible. As stated previously herein, roentgenographic examination of the bones of the skull will offer the most completely corroborative evidence of such defects if and when the bones are in-

volved. The most frequent error in the diagnosis of metastasis to bone is made in the misinterpretation of various types of benign osteodystrophia (defective or faulty nutrition of bone). Familiarly known as "osteitis deformans" (Paget's disease) or "benign osteitis," these types of benign osteodystrophia are not actually inflammatory conditions but are most probably the results of some type of interference with the arterial blood supply to bone. An identical etiologic factor in the sclerosis of bone in both conditions provides the confusing element in the differential diagnosis. Both conditions occur among men who are in the same age groups. Both are frequently revealed in the course of routine roentgenographic examination concerning lesions other than those in bone. The pathologic feature of benign osteodystrophia (Paget's disease) is subperiosteal deposition of osteoid tissue that actually elevates the periosteum and widens the cortical portion in the bone. In the roentgenogram there is, therefore, actual enlargement of the bone shadow. In the presence of metastatic carcinoma preliminary decalcification of the bone occurs; it is followed by reabsorption of the calcium which results in sclerosis of the bone and deepening of the density of the bone shadow. There is no enlargement of the bone shadow in the presence of metastasis to bone. All evidences of the trabecular elements of the bone are lost in metastasis to bone; in osteodystrophia there is an actual accentuation of the trabecular elements which produce in the bone shadow a densely striated appearance. Syphilis may cause sclerosis of bone, but the bone shadow in the presence of this disease is more homogeneously dense than it is in the presence of metastasis to bone. Sclerosis of bone in the bones of the pelvis among females should suggest syphilis as the etiologic factor. A roentgenogram which delineates the bones of the pelvis and the upper third portions of the femoral shafts is best suited for differential diagnosis. In cases of doubt, roentgenographic examination of the cranial vault and the tibia should be made. Metastatic carcinoma rarely involves the bones of the cranial vault; benign osteodystrophia frequently involves the cranial vault and the tibia, and when it does, the roentgenographic image is distinctively characteristic.

ROENTGENOGRAPHY AS COMPARED TO THE MICROSCOPIC EXAMINATION OF TISSUE

The roentgenogram is a reproduction in relief of all the tissues in any given part which have a sufficient density to offer any degree of resistance to the passage of the roentgen rays. Given adequate technique, the same information that is available in the cut section of tissue prepared for microscopic study can be obtained from the roentgenogram. The same careful study, under ideal conditions, is required for the roentgenogram as is required for the cut section.

The roentgenogram has aided the study of pathology immensely in supplying graphic illustrations of morbid processes in their various stages of progression or regression. A knowledge of roentgenology on the part of the pathologist and the anatomist and an application of this knowledge in their daily duties and in research has added much to the sum of knowledge in the study of disease and also of normal development.

The pathologist can carry to much greater lengths the subdivision of the groups into which I have divided the subject of this paper. For practical purposes this is not necessary. Benign osteogenic tumors are essentially chondromas. The variation of the predominant cellular element in the individual case may make a tumor a chondroma, a fibroma, an osteoma or any combination of these terms. The occurrence of myxomatous changes in any tumor of this group will add the word "myxo" somewhere in the combination of these terms. Study of the condition commonly referred to as "exostosis" reveals that both the single and multiple occurrences of this process in a patient lend themselves in

every respect to classification in the category of "benign osteogenic tumors." Every rule that applies to benign osteogenic tumors applies equally well to either form of exostosis. It is possible for multiple occurrences of chondroma to afflict an individual patient; the distribution of such occurrences varies with the type of congenital defect from which they have their origin. Recognition of these and the deformities they may cause as chondromas serves every practical purpose.

Osteogenic malignant tumors, similarly, can be widely subdivided into subperiosteal and medullary, periosteal, sclerosing, telangiectatic (bone aneurysm) tumors and chondrosarcomas, and each one of these will have a characteristic roentgenographic image. There are atypical forms, each one of which can be classified roentgenographically. But, again, all practical purposes will be served if these are identified simply as "osteogenic malignant tumors."

DIFFERENTIAL DIAGNOSIS

There are few lesions that can be mistaken for the benign tumors. Since practically all benign tumors are aberrations of normal growth or aberrations of normal reparative processes and represent the aftermath of trauma, any error in interpretation concerning these lesions will not have serious consequences or materially alter the prognosis for the patient.

To interpret a benign tumor erroneously as being malignant might have serious consequences to the patient, particularly if too much confidence was placed on the roentgenogram to the exclusion of careful correlation of the roentgenographic observations with all other findings. Strict adherence to the rule that all malignant tumors involving bone will show an abrupt dissolution of the cortical contour at some point will avoid the majority of gross errors concerning osteogenic malignant tumors. Ewing's tumor offers considerable difficulty at times in the matter of differential diagnosis. The tumor has its origin under the periosteum and the tissues react vigorously to its presence there. Infrequently is there evidence of involvement of the medullary portion of the bone. Involvement of the medullary portion is characteristic of osteomyelitis, with which Ewing's tumor most frequently is confused. A translucent portion in the medullary portion suggests the formation of abscess of the bone. The distinction between osteogenic sarcoma and Ewing's tumor is important because of the value of radiotherapy in one and the hopelessness of any method of therapy in the other. Much stress should be given to the appearance of the margins of the invasion shadow when the tumor extends to the contiguous soft tissue structures. Whenever the outline is discernible radiotherapy should be used to obtain diagnostic information. In all cases of doubt, radiotherapy can be used with benefit when osteomyelitis must be distinguished from Ewing's tumor.

Atypical occurrences in almost every type of lesion present a constantly changing list of conditions that can be mistaken for others than the true ones. Recognizing this, the experienced roentgenologist will insist on complete correlation of all roentgenographic evidence with that obtained in the taking of the history and by all other laboratory procedures. When this has been done and any shadow of doubt still persists he will demand, in the best interests of the patient, that biopsy be done and that the tissue obtained be examined by a thoroughly competent pathologist before any major surgical procedure which he considers not justifiable is carried out.

COMMENT

When human life and efficiency are at stake it must always be recognized that the fallibility of scientific methods rests largely with the persons who use them. Humility and a willingness to share responsibility are necessary attributes in the making of a successful roentgenologist.

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ATYPICAL GIANT CELL TUMOR*

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THE typical giant cell tumor is well recognized as a lesion which, while benign, is locally invasive and may recur after treatment. Its most frequent site is the epiphyseo-metaphyseal regions, with extension in advanced cases into the adjacent diaphysis. Save for rare exceptions, the lesion is subcortical in origin and tends to destroy the cancellous cortical bone. As it progresses, the cortex is reduced to a thin shell or may disappear entirely, although the periosteum remains as a limiting membrane offering resistance to extension into the overlying soft parts.

Distinctly atypical cases are rarely encountered. However, the importance of recognizing them is obvious, for unless their true nature is appreciated, the proper treatment cannot be carried out.

The atypical cases may be divided into two groups: (1) atypical because of clinical and pathological criteria, and (2) atypical because of location.

In the first group are those giant cell tumors that are malignant at the time of first observation, the diagnosis being based on a study of tissue removed prior to the administration of any form of treatment; and also those tumors that are believed to have undergone a malignant transformation following unsuccessful treatment, i.e., curettage, irradiation, or both.

In the second group is found that rare example of an expanding osteolytic lesion involving the shaft of a long bone rather than the extremity. The roentgenographic appearance does not simulate that of a malignant tumor, although, from its location, a benign giant cell tumor is not suspected. Under conservative surgery or irradiation this lesion responds in the manner of a giant cell tumor, and sections of tissue are so diagnosed by the pathologist, although, in some instances, a report of "angioma of bone" may be returned. In these cases, there may be reactive hyperplasia with fibrosis and giant cell areas.

As to the importance of these atypical giant cell tumors, it is obvious that those that are malignant from the outset should be recognized and treated as malignant tumors. This implies the use of radical surgery with or without preliminary irradiation.

In the more frequently observed examples of malignant transformation of a benign tumor, the factors that have led to such alteration of growth deserve a careful consideration. It must be acknowledged that a completely satisfactory explanation of the cause or causes of this alteration has never been offered. In collaboration with Stewart and Farrow[1] the records of the Memorial Hospital and the Hospital for Ruptured and Crippled were reviewed and found to contain 7 unquestionable examples of such malignant transformation of a previously benign giant cell tumor.

Where the tumor occupies an atypical location, it is essential that its benign nature be recognized so that conservative treatment can be employed. In one such case personally observed, a recurrence took place after biopsy and incomplete removal; irradiation, however, yielded an excellent result. It seems not unlikely that, in the past, amputation may have been performed for such tumors under the mistaken impression that the lesion was an osteogenic sarcoma of osteolytic type.

It seems well to call attention again to the variety of giant cell tumor known as Codman's *epiphyseal chondromatous calcifying giant cell tumor*. Codman collected a

[1] Stewart, F. W., Coley, B. L., and Farrow, J. H. Malignant giant cell tumor of bone. *Am. J. Path.*, 1938, *14*, 515–536.

* Panel Discussion, Clinical Congress, American College of Surgeons, October 22, 1940.

number of examples occurring in the upper end of the humerus. We have observed some that were situated in the upper end of the tibia. No doubt these tumors may be found in other locations as well. They often suggest osteogenic chondrosarcoma, and we know of at least one instance—occurring prior to Codman's classification—in which a shoulder joint disarticulation was performed in the belief that the latter diagnosis was correct. A histopathologic study of the tumor tissue is the only certain means of avoiding such an error.

A few examples of atypical giant cell tumors are cited briefly, as follows:

REPORT OF CASES

Case I. H. A. G., male, aged twenty-two, was first seen at the Memorial Hospital on May 25, 1931. Seven months earlier he had received a mild twist of the left knee while at work, and thereafter felt occasional twinges of pain in the knee accompanied by lameness and swelling. No relief was obtained from diathermy.

Local examination revealed a 1 cm. increase in the circumference of the left upper tibial region, with slight limitation of flexion and extension. A fullness was readily palpable on the inner side of the posterior tibial region. Roentgenograms showed a definitely demarcated lesion in the region of the epiphysis with slight evidence of trabeculation. There was a periosteal shadow, best seen in the lateral view, which circumscribed a soft-part shadow.

The treatment employed was curettage and cauterization with zinc chloride; closure of the wound without drainage.

Microscopic Diagnosis. Benign giant cell tumor.

The wound healed by first intention. Three weeks later the patient was walking without a limp. He has been followed ever since, the last examination being made in August, 1940, at which time he had full extension, flexion to 85°, and showed no evidence of a recurrence.

Case II. D. M., aged twelve, schoolboy, was first seen at the Memorial Hospital in May, 1939. Five weeks before he had sustained a

Fig. 1. Case I. Giant cell tumor, atypical because of location. *A*, May 8, 1931, preoperative roentgenogram. *B*, January 29, 1936, roentgenogram taken after operation.

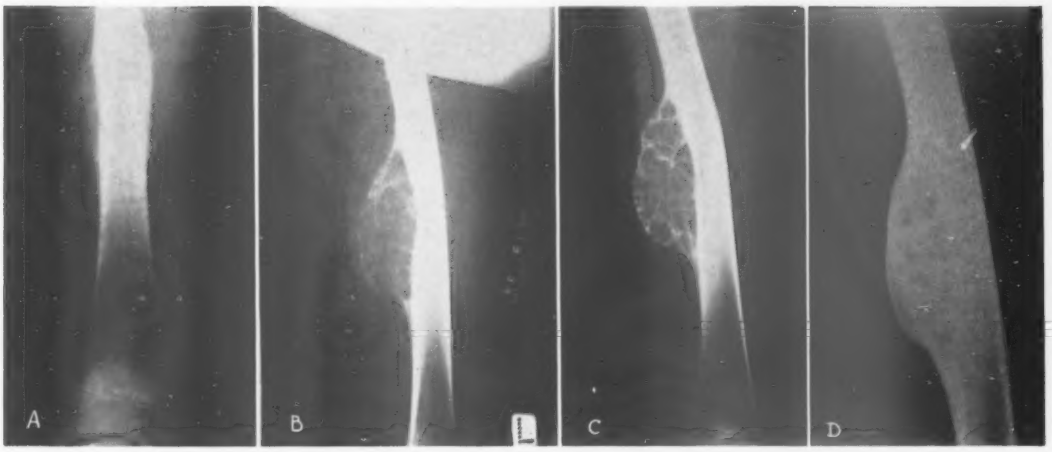

FIG. 2. Case II. Giant cell tumor, atypical because of location. *A*, May 10, 1939, preoperative roentgenogram; *B*, July 19, 1939, postoperative roentgenogram; *C*, September 13, 1939, roentgenogram taken after irradiation; *D*, December 26, 1940.

direct blow to the left thigh followed by pain, ecchymosis and interference with function.

Local examination showed the left thigh swollen at the juncture of the middle and lower thirds. The mass was tender on deep pressure and appeared smooth in outline. Extension and flexion of the leg was limited.

Roentgenographic examination revealed, near the mid-shaft of the femur, a tumor which was subcortical rather than medullary in origin. The relatively thin shell of bone suggested a comparatively benign process. In the opinion of the roentgenologist, however, there was a possibility that it might eventually develop more positive features of a malignant osteogenic tumor.

An exploratory operation and curettage of the tumor was carried out on May 11, 1939. The tumor mass was found to arise from the posterolateral aspect of the femur; it was subperiosteal; the cortical line was for the most part undisturbed. The operator felt that its appearance was more that of pressure than of a destructive lesion. Soft, reddish, granular tumor filled the area of involvement.

The microscopic report of Dr. Stewart read: "Despite the roentgenographic appearance, the histology is that of an aneurysmal giant-cell tumor of benign type." The tissue phosphatase was 2.3 units per gram. After an uneventful convalescence, the patient was discharged from the hospital on the seventeenth postoperative day.

Re-examination on July 20, 1939, disclosed marked increase in the size of the swelling, and films revealed an extension into both the shaft and the soft parts. Radiation therapy was carried out as follows: eight treatments totalling 30,000 r (14,000 r laterally and 16,000 r medially), 250 kv., 1.5 mm. copper filtration, 50 cm. target-skin distance; portal lateral was 8×12 cm., and medial, 15×12 cm.

Following this treatment, there was marked regression and the tumor area became ossified. For more than a year he has remained symptom-free, has attended school, and his activities have been unrestricted.

CASE III. E. E., aged thirty, housewife, was admitted to the New York Hospital in April, 1939, on the service of Dr. W. D. Andrus who has graciously permitted us to include the case in this series. Five months before admission, when the patient was eight months pregnant, she began to have intermittent, sharp, aching pain in the right knee. Following the normal delivery of the child, she suffered increase of pain, and in addition noticed a swelling of the right thigh. There was no limitation of movement or difficulty in walking.

Local examination revealed a hard, bony swelling in the upper third of the right thigh on the anterior and medial surfaces. It was not tender, movable or fluctuant. The movements of the thigh and knee were unimpaired. Roentgenograms of the chest were negative. Serum phosphatase was 6.4 units per gram.

Roentgenographic Diagnosis. Bone tumor of

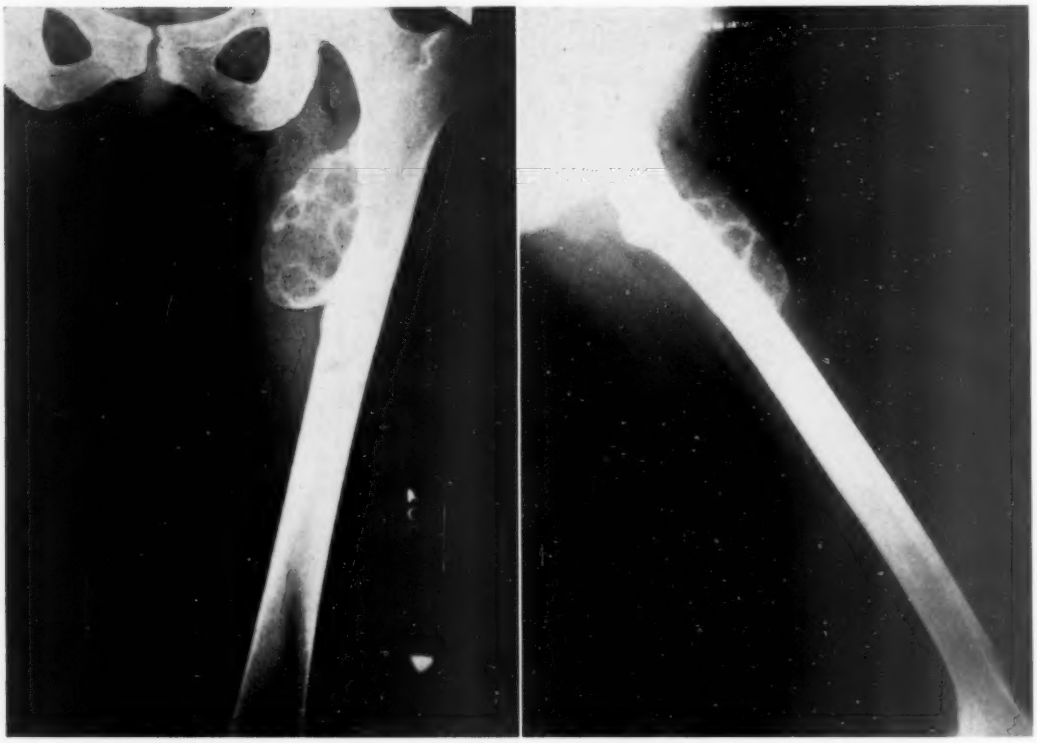

Fig. 3. Case III. Giant cell tumor, atypical because of location. Roentgenograms taken before operation.

Fig. 4. Case III. Roentgenograms taken after operation.

the myxosarcoma, osteochondrosarcoma type.

On operation, May 2, 1939, Dr. Andrus exposed a large tumor of broad base. It had a thin shell within which there was soft, red material. The frozen section diagnosis was that of giant cell tumor. The entire tumor was curetted out and the bony shell removed completely. After carbolization of the area, the wound was closed. The postoperative roentgenogram showed a complete removal of the tumor.

Following an uncomplicated convalescence, with primary wound healing, the patient has remained well.

Case iv. H. A., aged forty-seven, female, unmarried, was admitted to the Memorial Hospital on May 10, 1940, complaining of pain and swelling in the left knee over a period of two years. A roentgen diagnosis of arthritis had been made in February, 1939, and the patient was kept in bed for three weeks. During the past two years she had sustained four falls on the knee, the last one occurring a month prior to her admission. The knee was then put in a cast, a roentgenogram was taken, and the patient was referred to the Memorial Hospital.

Fig. 5. Case iv. Malignant giant cell tumor in an unusual location.

Fig. 6. Case iv a few weeks later. Note marked soft tissue swelling and bone destruction.

Local examination revealed the affected patella to be three times the size of the normal one. It was freely movable and there was no skin attachment. Films showed an entirely osteolytic process involving the greater part of the patella with accompanying soft tissue swelling. Submitted films taken in February, 1939, showed that a definite osteoporotic process in the inferior two-thirds of the patella was present at that time. The roentgen diagnosis was that of chondromyxosarcoma or giant cell tumor of the patella.

Tissue removed at aspiration biopsy was examined by Dr. Stewart, pathologist, who reported "malignant tumor, ? malignant giant cell tumor."

A total extirpation of the patella was carried out on May 13, 1940. The patella was found to be almost completely replaced by a tumor measuring 6×6×2.5 cm. It was soft, yellowish-

Fig. 7. Case v. Atypical because of long duration of symptoms, yet at operation a malignant giant cell tumor was found. Patient has survived amputation fourteen years.

white and showed multiple cystic areas of necrosis and hemorrhage. It did not invade the overlying fascia. While there had been erosion and invasion of the articular cartilage posteriorly, the articular surface was intact. On microscopic examination, Dr. Stewart reported it to be a malignant giant cell tumor. A postoperative course of toxin treatment (Coley's) was given, and the patient was discharged on June 21, 1940.

Physical examination two months later shows that she has full extension of the knee with flexion to 135° and is able to walk without crutches.

Case v. I. L., white female, aged thirty-one, married, was first seen at the Memorial Hospital in October, 1930, complaining of pain in the left lower leg. Thirteen years previously she had first felt discomfort in the leg; this was persistent but not very painful. In 1926, she was operated upon at the Hospital for Bone and Joint Diseases, supposedly for osteomyelitis of the fibula. The wound drained postoperatively for three weeks and then closed. Only an occasional pain was felt until three months before admission when a constant dull ache developed.

Local examination revealed a soft swelling which gave prominence to the outer aspect of the upper fibular region of the left leg. The circumference of the leg at the point of greatest swelling was 1 inch greater than that of the corresponding level of the opposite leg.

Roentgenograms taken over a four year period were available for comparison. The early ones suggested a chronic sclerosing osteitis with little change over a period of three years. The films taken two weeks prior to admission, however, disclosed a semilunar-shaped area of almost complete osteoclasis, without evidence of any new bone formation.

While it was believed that the condition was benign, a surgical biopsy was considered necessary to rule out superimposed sarcoma. This was done, and Dr. Ewing's report was "malignant giant cell tumor." The patient was given radium therapy, 40,000 millicurie-hours to both the lateral and medial aspects of the leg (total 80,000 mc-hr.) using the 4 gram pack placed at 6 cm. distance. Four days later, a mid-thigh amputation was performed.

Grossly, the fibula appeared to be the main seat of the tumor which measured 9.5×6×4 cm. The periosteum was perforated, and the tumor suggested a cartilaginous origin. Bisection of the shaft of the fibula revealed an osteolytic area with dense osteoid reaction and thickening of the cortex.

Microscopic report by Dr. Stewart: "An unusual tumor: areas of fibrous osteitis. Other foci of typical benign giant cell tumor and more areas of malignant polyhedral, spindle and giant cell sarcoma. The tumor is malignant and blood vessels are probably invaded."

The diagnosis of malignant giant cell tumor was concurred in by the Bone Sarcoma Registry (Case No. 1246). A course of Coley's toxins was given postoperatively (20 injections). In May, 1939, the patient had a supracervical hysterectomy for pregnancy, complicated by multiple fibromyomata; otherwise, she has remained well with no evidence of disease for a period of ten years.

Case vi. S. B., aged sixteen, schoolboy, was referred to the Memorial Hospital from the Trenton Orthopedic Hospital in April, 1937,

complaining of pain and swelling of the right leg below the knee. Pain on pressure had been present for six months. For two months there had been a slight but noticeable swelling, and for a month and a half there had been continuous pain in the leg, especially at night or while resting the leg. There was no history of trauma. He had no other symptoms. The general physical examination was essentially negative.

Local examination revealed a rounded swelling on the anterior surface of the right tibia, 5×4 cm., beginning 6 cm. below the inferior border of the patella. There was moderate tenderness to palpation; no skin changes or fluctuation.

Roentgen examination revealed an area of destruction extending from the tibial tubercle down the shaft anteriorly for a distance of 2½ inches and posteriorly for half this distance. It was roughly ovoid in shape and appeared to have its origin in the medullary portion of the bone or cortex beneath but was surrounded by periosteum. No bone reaction was noted. It lacked the features of a benign giant cell tumor and appeared at least potentially malignant. Clinical diagnoses of abscess, chondroma, bone cyst and osteogenic sarcoma were considered. That of giant cell tumor was held improbable because of the location in the diaphysis.

Two aspiration biopsies were done. At the first, only blood was obtained. The tissue from the second was reported to be benign giant cell tumor. Accordingly, the patient was admitted to the hospital and an operation performed on May 10, 1937. On exposure there was a thin layer of bone overlying a small spongy hemorrhagic and gelatinous mass which had extended into the marrow cavity. This was thoroughly curetted, swabbed out with saturated solution of zinc chloride, and closed without drainage. The curettings were examined microscopically by Dr. Fred W. Stewart, whose opinion was later confirmed by the Bone Sarcoma Registry, viz., fibrosing ossifying giant cell tumor.

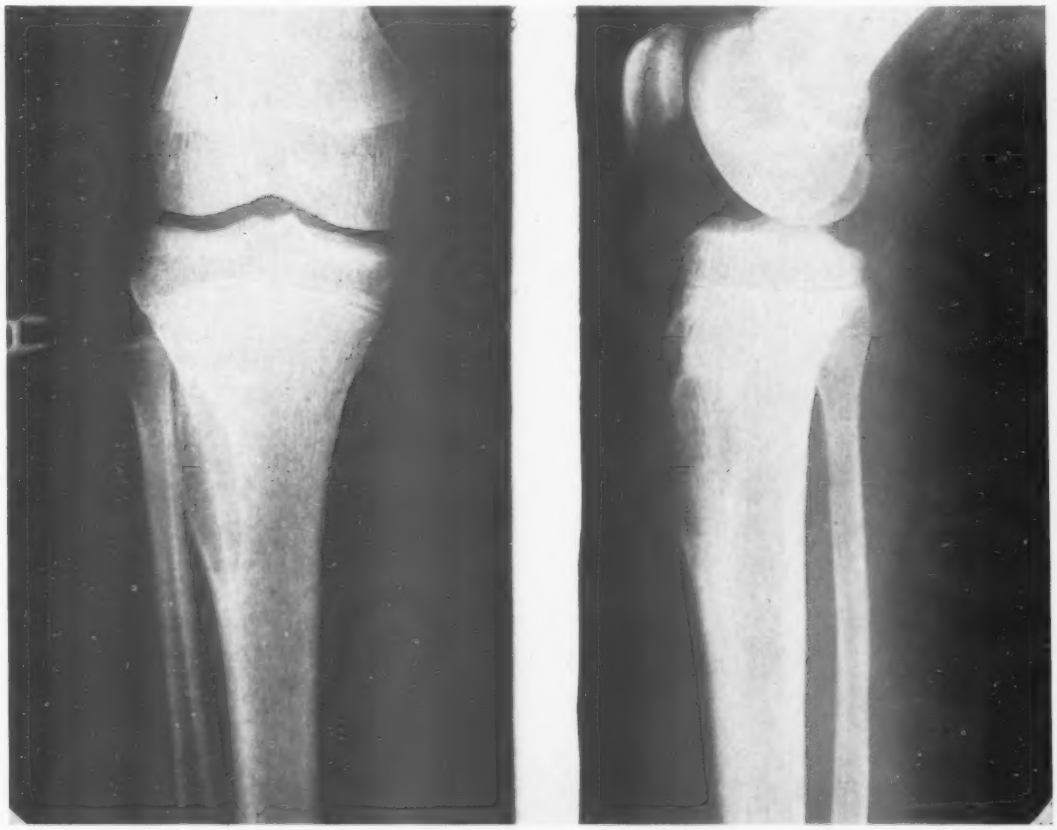

Fig. 8. Case vi. Giant cell tumor, atypical because of location which, in a patient of this age, is more characteristic of bone cyst.

Fig. 9. Case vii. Codman's epiphyseal chondromatous giant cell tumor of the humerus.

The patient made an uneventful recovery and has remained well with perfect function of the limb for the past three years.

Case vii. A. F., aged fifteen, schoolboy, was first seen in the Memorial Hospital out-patient clinic on February 18, 1924. His history stated that six months previously he had experienced a sudden pain in the upper right humerus. This gradually became worse so that three months later he was unable to abduct this arm. Three months thereafter he noticed a slight swelling in the same region which gradually and steadily increased in size. He was unable to sleep on account of the pain. Several electric treatments had been given without relief.

Local examination revealed atrophy of the muscles of the right arm. There was pain on abduction. The upper end of the humerus was the site of a smooth, firm, ovoid enlargement which was tender anteriorly.

While the previous clinical diagnosis was that of giant cell tumor, following a roentgenographic examination a diagnosis of osteochondrosarcoma was made. The patient was presented at the staff conference of the Memorial Hospital, and it was the consensus that the condition was one of chondrosarcoma.

Roentgen Therapy. In February, 1924, three treatments were given, eighty minutes each, using 4 ma. current, 90 inch spark gap, 0.5 mm. copper and 0.5 mm. aluminum filter, at 50 cm. skin-target distance, or about 700 roentgens, measured in air, for each treatment, making a total of 2,100 roentgens.

Following this therapy, the condition improved, the process showing a steady increase in density. An examination five years later showed the patient in excellent general condition with no active disease. For the past ten years he has been lost to follow-up.

This case is registered in the Bone Sarcoma Registry (No. 603) as a benign giant cell tumor. It has been selected by us as a typical example of Codman's epiphyseal chondromatous giant cell tumor.

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A ROENTGENOLOGIC AID IN THE DIFFERENTIATION OF ORGANIC FROM NON-ORGANIC MITRAL (FLINT'S) MURMURS*

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IN 1862 Austin Flint reported 2 cases of aortic insufficiency with apical diastolic murmurs like those heard with mitral stenosis. At necropsy both patients had normal mitral valves. Since then apical diastolic murmurs have been heard in patients with marked anemia and acute or subacute rheumatic myocarditis. The time relationships, quality, location and other characteristics of this diastolic murmur of functional mitral stenosis are very similar to those of organic origin.[1]

Apical systolic murmurs indistinguishable from those of mitral insufficiency also have been heard in patients with aortic valve disease. McGinn and White[2] observed such murmurs in patients with aortic stenosis which often had been incorrectly diagnosed as mitral valve disease.

The roentgenologist is sometimes asked to help decide whether a mitral murmur is organic or non-organic on the basis of the roentgen findings. A teleroentgenogram may show sufficient change in the cardiac outline to warrant a conclusion of mitral valve disease. However, the so-called "mitral configuration" may be masked by cardiac enlargement, and conversely a frontal silhouette simulating mitral disease may be seen with normal mitral valves.

A reliable indication of mitral disease is enlargement of the left auricle.[3] This can readily be demonstrated by roentgenoscoping the patient in the right anterior oblique position after administering a barium bolus. Indentation of the esophagus by a protruding left auricle is an excellent indication of its enlargement, and often exists when the frontal silhouette of the heart is normal. In more advanced cases right ventricular enlargement occurs, which likewise can be demonstrated roentgenoscopically.

It might be possible, then, to differentiate between organic and non-organic mitral murmur by investigating the heart from the viewpoint of selective enlargement of the left auricle. Patients with combined mitral and aortic valve defects present definite left auricular as well as left ventricular enlargement, while those with aortic valve disease have little or no left auricular enlargement.

Slight left auricular dilatation may be associated with left ventricular hypertrophy due to hypertension, nephritis or aortic insufficiency. However, differentiation is not difficult, since concomitant mitral valve disease in the latter group causes greater left auricular enlargement with deeper esophageal indentation than is seen in similar patients with normal mitral valves.

An opportunity to investigate this supposition presented itself in 12 patients. Postmortem confirmation was obtained in five. Two patients with combined mitral and aortic valvular disease and one patient with loud functional murmurs are included as controls.

REPORT OF CASES

CASE 1. J. A., male, aged sixty-three, had rheumatic fever twenty years ago and was informed of cardiac involvement then. In 1932 a systolic apical murmur transmitted to the axilla and aortic systolic and diastolic murmurs were heard. His pulse was of the Corrigan type. In 1936 double mitral and aortic murmurs appeared. His blood pressure was 170/60. An electrocardiogram showed prolongation of the auriculoventricular conduction time to 0.22 second.

During November, 1939, he complained of dyspnea, weakness and chest pain. He was mildly cyanotic and required constant bed rest. Systolic and diastolic murmurs were heard over the mitral and aortic areas. His blood pressure

* From the Radiologic Service of Dr. M. G. Wasch, The Jewish Hospital of Brooklyn.

was 130/90. A note by the medical consultant read, "Crescendo presystolic and blowing systolic at the apex, diastolic at the aortic are definitely indicative of a valvular defect both at the mitral and aortic orifices due to rheumatism."

Teleroentgenographic examination of his heart showed enlargement towards the left.

At necropsy there was calcification both of the aortic ring and leaflets, stenosing the valve orifice. The mitral valve was normal. The heart weighed 580 grams. The left auricle was not appreciably enlarged.

Comment. This patient had calcareous aortic stenosis. Clinically the impression was that he had a mitral as well as an aortic lesion. The absence of left auricular enlargement may be taken as indicative of a normal mitral orifice, and might readily have been diagnosed roentgenoscopically.

Case II. D. W., female, aged fifty-seven, complained of dyspnea on exertion, paroxysmal nocturnal dyspnea and ankle edema for several years. There was no known rheumatic infection. The dyspnea had increased in severity during the past year. She was slightly cyanotic. Examination revealed a rough, loud systolic blow over the aortic area and a harsh blowing systolic and diastolic murmur over the apex. Her blood pressure was 145/0. An electrocardiogram showed a P-R interval 0.20 second long, left axis deviation and inverted T-waves in the first and second leads.

Roentgen examination was limited to a bedside roentgenogram which showed generalized cardiac enlargement and congestive changes in the lungs. The patient died during an episode of pulmonary edema. The clinical diagnosis was rheumatic heart disease with mitral and aortic valve disease.

At necropsy the heart weighed 520 grams. The aortic leaflets were calcified and stenosed. The aortic valve annulus was normal. The mitral leaflets were thin and delicate, the left auricle was not dilated. The left ventricle was 1.9 cm. thick, the right 0.7 cm.

Comment. Although the patient had clinical evidences of both aortic and mitral disease, the cardiac lesion was limited to the aortic valve. The normal size of the left auricle may be regarded as indicative of a normal mitral valve.

Case III. P. S., female, aged fifty-nine, complained of weakness, weight loss and a morning cough productive of yellow blood-tinged sputum for one year. Her general health had been excellent until then. There was no known rheumatic history. When admitted to the hospital she complained of chest pain and was in moderate congestive heart failure.

Systolic and diastolic murmurs were heard both over the aortic and mitral areas. The aortic murmur was particularly loud and coarse. The clinical impression was "chronic rheumatic heart disease with double aortic and mitral valve lesions." Repeated electrocardiograms showed increase in the conduction time to 0.26 second. Roentgenoscopic examination of the heart showed marked enlargement of the left ventricle, the remaining three chambers being definitely less enlarged. Aortic valve calcifications were seen. The aortic pulsations were of the type seen with aortic insufficiency. The patient died during a sudden attack of pulmonary edema.

The heart weighed 500 grams at autopsy. There was calcareous stenosis of the aortic valve. The annulus of the mitral valve was calcified, the leaflets were normal. The left auricle was not dilated, the left ventricle measured 1.7 cm.

Comment. The roentgenoscopic findings indicated the possibility of Flint's murmur because there was only slight left auricular enlargement. Calcification of the mitral annulus does not impair the efficiency of the valve, so the effective pathology was practically limited to the aortic valve. The apical murmurs must be regarded as functional.

Case IV. E. S., male, aged fifty-one, complained of increasing dyspnea associated with exertion for four years. Precordial pain and an occasional small hemoptysis were present for eighteen months. Serological examination was positive for syphilis, and he had received treatment for several years up to eighteen months before admission. There was no history of a rheumatic infection.

Six months before admission his blood pressure was 200/90, on admission it was 120/80. Harsh loud systolic and diastolic murmurs over the aortic area and a blowing systolic murmur over the mitral region were heard. His liver was enlarged and tender. Roentgen examination was limited to a bedside chest film which

showed massive cardiac enlargement and pulmonary congestion. The clinical diagnosis was luetic heart disease with aortic insufficiency. He died during an attack of pulmonary edema.

At autopsy the heart weighed 1,020 grams, the left ventricular myocardium was 3 cm. thick, the right 0.8 cm. There was marked aortic stenosis with calcareous changes in the leaflets. The mitral valve was normal. The left auricle was slightly dilated. Luetic scarring was present both in the ascending and descending thoracic aorta. A thrombus was found in the right coronary artery.

Comment. This patient had a transmitted apical systolic murmur with calcareous aortic stenosis. This had been correctly interpreted antemortem. The etiologic factor of the aortic valve disease was considered rheumatic inasmuch as the calcification was limited to the leaflets. The luetic process was considered coincidental. In spite of the enormous size of the left ventricle, the left auricle was only slightly dilated.

Case v. E. M., female aged fifty-eight, was told she had a "leaky valve" twenty years ago. There was no complaint referable to the heart until six months before admission. Her initial complaints were dyspnea on exertion, chest pain and ankle edema which became progressively worse. The Wassermann reaction on both the blood and cerebrospinal fluid was positive.

Physical examination showed a harsh loud aortic systolic and diastolic murmur transmitted to the neck and along the left sternal border. A long rumbling diastolic murmur followed by a blowing systolic murmur was heard at the apex. Her pulse was of the Corrigan type, her blood pressure 145/50.

The patient was given a course of ouabain intravenously and improved temporarily. During this brief remission the apical diastolic murmur disappeared only to return the next day when the patient's condition became worse. The clinical diagnosis was luetic heart disease, aortic insufficiency with Flint's murmur.

Roentgen examination of the chest showed generalized cardiac enlargement with a rather small aortic knob.

At autopsy the heart weighed 470 grams, the left ventricle was dilated and hypertrophied, the left auricle was normal. There was calcareous aortic stenosis. The mitral valve was normal. No luetic changes were seen in the aorta.

Comment. In all probability the luetic condition and cardiac pathological condition were coincidental because the etiological factor causing the aortic valve changes was believed to be rheumatic. The apical murmurs were correctly interpreted although there were several observers who diagnosed organic mitral disease.

Case vi. S. K., male, aged fifty-three, was first informed that he had heart disease twenty years ago when he was "rated up" as an insurance risk. There had been no known episodes of rheumatic fever. His complaints at the time of examination were not related to his cardiovascular system.

Physical examination revealed a coarse rough aortic systolic and blowing diastolic murmur transmitted along the left sternal border. Apical systolic and presystolic murmurs were present. His blood pressure was 145/75. The clinical diagnosis was rheumatic mitral and aortic stenosis and insufficiency.

Roentgenoscopic examination revealed moderate left ventricular enlargement. The other chambers were normal. Calcific deposits in the aortic valve region were identified. The aortic pulsations were not hectic.

Comment. Inasmuch as there was neither left auricular nor right ventricle enlargement the clinical diagnosis was changed to calcareous aortic valve disease with aortic stenosis. The apical murmurs were of the Flint type.

Case vii. N. G., female, aged thirty, had rheumatic fever with cardiac involvement nineteen years ago. There had been no recurrences and the patient remained well compensated. During March, 1939, a systolic blow was heard at the mitral and aortic areas. Six months later a systolic and diastolic murmur was heard at the apex and a diastolic murmur was heard along the left sternal border. Her blood pressure was 135/65. The clinical diagnosis was rheumatic heart disease, mitral stenosis and insufficiency, wel compensated.

Roentgenoscopic examination revealed hectic aortic pulsation which might be compared to the Corrigan pulse. The left ventricle was slightly enlarged. The left auricle and right ventricle were normal.

Comment. After the roentgenoscopic report of a normal left auricle the clinical

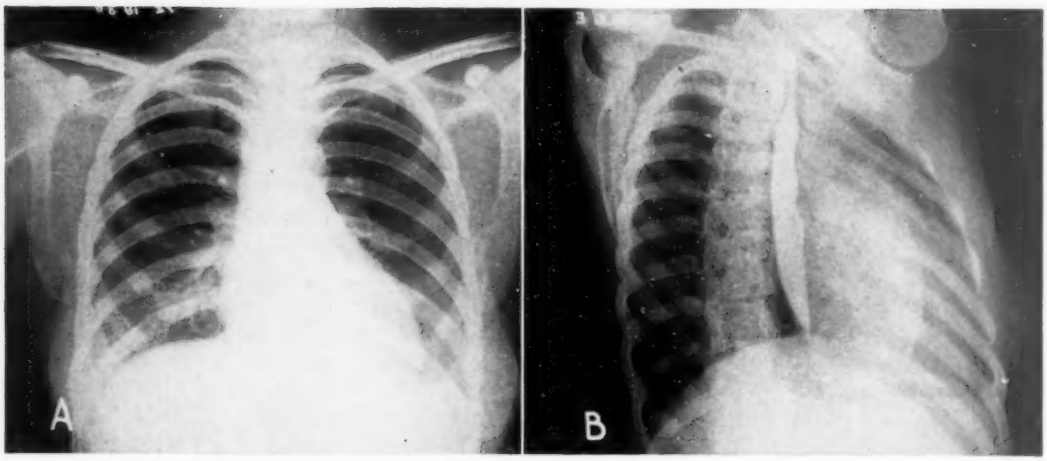

Fig. 1. Case vii. *A*, teleroentgenogram showing slight broadening of the cardiac silhouette towards the left *B*, right anterior oblique projection showing normal course of the esophagus. The mitral murmurs in this patient are functional.

diagnosis was amended to rheumatic heart disease, aortic insufficiency with Flint's murmur. If the conclusions drawn from this case are correct, it is likely that Flint's murmur may occur without marked cardiac enlargement during the evolution of aortic insufficiency.

Case viii. A. McV., female, aged forty, had no complaints referable to the heart, nor were there any indications of a previous rheumatic infection. Examination showed a short rough presystolic murmur and a coarse loud systolic aortic murmur. A short presystolic and long blowing diastolic murmur was heard at the apex. Her blood pressure was 190/80.

Roentgenoscopic examination showed slight left ventricular enlargement. The remaining chambers were normal. Calcific deposits in the aortic leaflets were identified. An electrocardiogram showed an increase in the auriculoventricular conduction time to 0.22 second. The clinical diagnosis was rheumatic heart disease with mitral and aortic stenosis

Her physical condition and findings remained unchanged during the next two years. Cardiac roentgenoscopy during May, 1940, showed no change in the size of her heart. The aortic pulsations were hectic, and the aortic valve calcifications again were easily demonstrated.

Comment. The diagnosis of multiple valve defects in this patient was changed to calcareous aortic stenosis and insufficiency. The absence of left auricular enlargement was considered indicative of a normal mitral valve.

Case ix. M. M., male, aged forty-four, was first seen in 1931 because of pain in the right side of his chest. At that time physical examination showed no cardiac abnormalities. He returned five years later complaining of migratory joint pains. Physical examination revealed extrasystoles, and soon thereafter a systolic and diastolic apical murmur was noted. Electrocardiographic examination showed increased auriculoventricular conduction time to 0.24 second. A teleroentgenogram was reported as "not typical of a mitral lesion but rather appears to simulate a hypertensive type of heart."

During February, 1937, a double aortic and mitral murmur was heard. His blood pressure was 170/80. Cardiac roentgenoscopy during June, 1937, revealed calcified aortic valves and an enlarged left ventricle. The left auricle was normal. The auriculoventricular conduction time was again 0.24 second long.

During January, 1938, he complained of pain across his chest during exertion. A rough, long systolic and blowing diastolic murmur over the base transmitted along the left sternal border, and apical systolic and diastolic murmurs were heard. His blood pressure was 190/60. Similar findings were observed during May, 1939.

The clinical diagnosis originally was rheumatic heart disease, mitral and aortic involvement. After cardiac roentgenoscopy the diagnosis was altered to calcareous aortic valve disease with Flint's murmur.

Comment. Roentgenoscopic estimation of the size of the left auricle was helpful in deciding whether the apical murmur was organic or functional.

Case x. M. C., male, aged sixty-four, had syncopal attacks for one year. These first occurred while he was walking, and were accompanied by substernal pain, nausea and vomiting. Later the attacks occurred while he was at rest.

On examination a loud musical systolic murmur was heard over the entire precordium transmitted to the apex and back. A hypersensitive carotid sinus reflex was elicited.

Roentgenoscopic examination showed an enlarged left ventricle, a normal left auricle and calcified aortic valves. The clinical impression was calcareous aortic valve disease with aortic stenosis.

Comment. This is another illustration of the transmission of a basal murmur to the apex in a patient with calcareous aortic stenosis.

Case xi. J. T., male, aged fifty-seven, was admitted for a cataract operation. During the routine physical examination a harsh loud systolic murmur was heard over the aortic area and at the apex. His blood pressure was 105/70.

Roentgenoscopic examination showed moderate left ventricular enlargement and calcareous aortic leaflets. The left auricle was normal. The clinical diagnosis was calcareous aortic stenosis.

Comment. This patient also illustrates the transmission of an aortic murmur to the apex with calcareous aortic stenosis. The patient was unaware of cardiac disease.

Case xii. N. G., male, aged forty-six, was first seen in May, 1937, during an episode of acute pulmonary edema. He did not know he had heart disease.

Physical examination after he recovered compensation showed a loud rough aortic systolic and diastolic murmur and a presystolic and blowing systolic apical murmur. His blood pressure was 180/50. The opinion of the medical consultant was that the patient had rheumatic heart disease with double mitral and aortic valve defects.

Roentgenoscopic examination of his heart two months later showed massive left ventricular enlargement and slight left auricular dilatation. The aortic valves were calcified. The aorta was considerably dilated.

The blood Wassermann was 4 plus. The patient improved on conservative treatment directed towards the cardiac condition. It was believed inadvisable to subject him to antiluetic therapy.

He was again seen in July, 1940. There had been little discomfort aside from moderate dyspnea on exertion. His heart findings were unchanged.

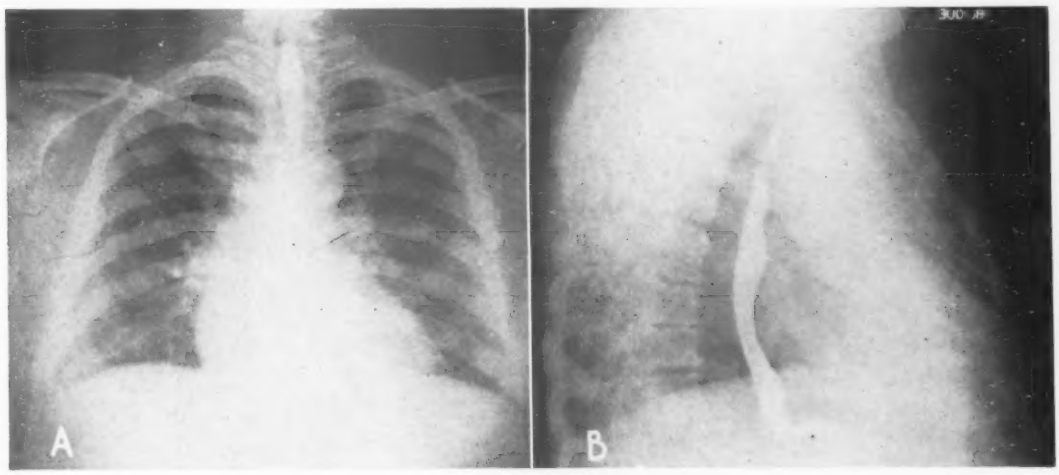

Fig. 2. Case xiii. *A*, teleroentgenogram showing a cardiac contour similar to that of Figure 1*A*. *B*, right anterior oblique roentgenogram showing impression of enlarged left auricle on barium filled esophagus. The apical murmurs in this patient are due to organic mitral valve pathology.

Comment. The clinical diagnosis was changed to calcareous aortic valve disease with aortic stenosis and insufficiency. The apical murmurs were considered to be of the Flint type. The coincidence of rheumatic and luetic cardiovascular disease in this patient is quite likely.

Case xiii. O. L., male, aged forty-one, had been seen in the outpatient department in 1921. No abnormal cardiac findings were noted at that time. He was seen frequently because of a "conversion hysteria." In August, 1935, a short apical systolic blow was heard. On April 22, 1938, a harsh short apical systolic and a double aortic murmur were heard. His blood pressure was 155/90. The clinical diagnosis was rheumatic heart disease, aortic stenosis and insufficiency and mitral insufficiency.

Roentgenoscopic examination showed definite left auricular enlargement with posterior deviation of the barium filled esophagus and moderate right and left ventricular enlargement. Calcareous deposits were seen in the aortic valve.

Four months later a rough systolic and diastolic murmur was heard at the aortic area transmitted down the left sternal border. A loud apical systolic murmur was present.

Comment. In view of the left auricular enlargement the apical murmur was considered indicative of mitral disease.

Case xiv. S. G., male, aged forty-three, had been confined to bed for three weeks during 1936 because of swollen joints and fever. A systolic apical murmur transmitted to the axilla and a louder aortic systolic murmur had been heard at that time. During June, 1937, he complained of precordial pain. A rough systolic aortic murmur, an aortic systolic thrill and a rough mitral systolic murmur was noted. He was again seen in May, 1938 ,with similar complaints and findings.

Roentgenoscopic examination in September, 1938, revealed moderate cardiac enlargement with posterior deviation of the esophagus indicative of left auricular enlargement. In May, 1939, and February, 1940, he again visited the clinic complaining of dyspnea and precordial pain. There were very loud systolic murmurs both at the apex and base and a loud apical diastolic murmur. The aortic second sound was not heard.

Comment. The presence of definite left auricular enlargement and right ventricular enlargement supports the diagnosis of mitral disease as well as aortic disease.

Case xv. E. R., male, aged twenty-seven, had a primary penile lesion six years ago. Antiluetic therapy had been started about four months before the patient was admitted. The patient became slightly jaundiced about a week before admission. The jaundice deepened, and a diagnosis of toxic hepatitis secondary to arsenic therapy was made. Physical examination revealed a loud systolic murmur both at the aortic and mitral areas. Some observers believed they could hear a mitral presystolic murmur.

The murmurs were interpreted as functional by some, and as indicative of luetic heart disease by others. A teleroentgenogram showed no change in the size or contour of the heart.

At autopsy the heart weighed 235 grams. The chambers and valves were normal.

Comment. This report is included to illustrate the occurrence of functional murmurs without cardiac enlargement.

SUMMARY

1. It is difficult to distinguish Flint's murmur of functional mitral stenosis from that due to mitral disease on the basis of the physical findings alone. Similar difficulties exist in identifying the apical systolic murmur sometimes heard with aortic valve disease.

2. Since mitral disease almost always causes left auricular enlargement, while functional murmurs occur at the mitral region without valvular pathology or chamber enlargement, a basis for their differentiation may be established.

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THE CARDIOVASCULAR SYSTEM OF AMERICAN ROENTGENOLOGISTS BEYOND THE AGE OF FORTY-FIVE YEARS*

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THE following investigation was carried out in consideration of certain effects of the roentgen rays on the endocrine system and the relationship of the latter to cardiovascular pathological conditions.

The hormones of the suprarenal glands, both adrenalin and the cortical sterols (adrenocortical or "AC" compounds), are of fundamental importance in the development of arteriosclerosis, arterial hypertension, angina pectoris and myocardial decompensation. They are absorbed and deposited in the arterial walls and in the myocardium and, if present in excessive amounts, contribute to functional, metabolic and structural changes of the tissues which ultimately lead to the above named clinical phenomena. There exists experimental, clinical and morphological evidence of such detrimental effects of an intense suprarenal activity going on over years and decades, not only in the presence of suprarenal tumors but also in the common forms of essential hypertension and of angina pectoris (abnormally intense abrupt discharges of adrenocortical compounds into the blood, particularly during physical exercise) and of cardiac failure (abnormally high adrenocortical concentrations within the heart muscle) (Raab[25,27]). Moreover, adrenalin is formed within the tissues of the cardiovascular system all over the body by adrenergic sympathetic neurons (Cannon and Lissak). The latter amounts of adrenalin can be assumed to participate essentially in the processes which lead to local vascular and myocardial damage.

On the other hand, it is known from experimental and clinical experience that an abnormally intense activity of endocrine glands in general can be suppressed through roentgen irradiation. The abnormal adrenocortical discharges in angina pectoris patients are abolished by roentgen treatment of the adrenal glands with long lasting beneficial therapeutic results in the majority of the cases (Raab;[26,27] Hadorn, Schittenhelm, Lippross). Also irradiation of the chest has been found useful in angina pectoris by Lian, Barrieu, and Nemours-Auguste, Gilbert, Sussman, Wasch and Schenck, and others. Certain forms of paroxysmal arterial hypertension can be influenced in a similar manner (Langeron and Desplats). Irradiation of the hypophysis and of the adrenal glands was found to improve essential hypertension according to Hutton, and hypertension in Cushing's disease (Cushing, Dattner, Lawrence, Jamin). Peripheral arteriosclerotic disturbances of the extremities could be favorably influenced by local roentgen irradiation or by irradiation of the suprarenal glands or by a combination of both (Delherm and Beau, Gilbert and Babaiantz, Hippe and Hähle, Langeron and Desplats, Raab,[28] Zimmern, Chavany and Brunet). It seems possible, therefore, that prolonged exposure of the entire body, or at least of large areas, to minute doses of roentgen rays might prevent to a certain extent the stimulating and later exhausting and destructive effect of excess amounts of adrenalin and cortical sterols on the cardiovascular system.

It was assumed that the cardiovascular condition of roentgenologists beyond the age of forty-five years might possibly give some information, although it was realized from the beginning that the modern means of protection make a real exposure doubtful in many instances and eliminate the possibility of a quantitative estimation of radia-

* This study was aided by a grant from the Rockefeller Foundation.

tion effects on the persons in question. In a comment on this plan of research Dr. Fred J. Hodges of the University of Michigan made the following statement: "Testing of working quarters and practices with highly sensitive measuring apparatus often shows excessive daily exposure when protection was thought to be adequate, and sometimes the reverse is true."

In full awareness of the necessity to exert due restraint in drawing conclusions from the results, a detailed questionnaire concerning features of cardiovascular behavior was sent out to 737 roentgenologists of the United States and Canada. Three hundred and forty-four of these questionnaires were returned with the main questions answered.

While this inquiry was under way, I became acquainted with a similar action taken in 1921 by Dr. George E. Pfahler of the University of Pennsylvania which, however, was chiefly concerned with hematologic details. Three hundred and thirty-eight blanks were returned of one thousand distributed among American radiologists and their staffs. In order to evaluate the degree of exposure in the individual cases Dr. Pfahler requested that each person questioned carry a dental film in his pocket for two weeks. Two workers in his own laboratory were thus found to receive about 1/2400 of an erythema dose. "The majority of the films sent in showed no more but many were entirely black." "Those who work with radium or with the

TABLE I

Age Years	Number of Cases	Average Blood Pressure		Number of Smokers	Average Number of	
		Systolic	Diastolic		Hours of Daily "Exposure"	Years of Roentgen-Ray Work
45	19	123	83	15	4	16
46	18	126	82	11	4	19
47	19	121	78	11	5	16
48	27	123	81	16	4	19
49	19	126	82	14	5	21
50	31	129	85	22	5	21
51	15	125	82	10	7	20
52	27	128	81	25	5	21
53	18	127	81	12	6	21
54	12	132	84	6	4	24
55	10	131	85	5	4	22
56	20	126	81	17	6	24
57	12	128	83	8	4	24
58	13	135	85	6	6	26
59	10	131	83	4	6	27
60	15	127	81	10	6	27
61	7	145	86	3	5	25
62	10	132	87	5	5	28
63	3	128	85	3	4	24
64	12	134	86	10	4	31
65	6	130	82	4	6	24
66	2	118	71	0	7	40
67	4	125	80	2	5	32
68	6	131	76	5	6	28
69	3	120	74	2	4	27
71	2	150	85	1	4	40
72	1	130	?	1	2	27
73	1	88	38	0	4	40
74	1	152	100	0	9	22

TABLE II

Age Group	Number of Cases	Average Blood Pressure of Roentgenologists		Normal Blood Pressure of Corresponding Age Group*		Difference in mm. Hg	
		Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic
45–49	102	124	81	128	85	− 4	−4
50–54	103	128	83	130	86	− 2	−3
55–59	65	130	83	134	87	− 4	−4
60–64	47	133	85	135	87	− 2	−2
65–74	27	126	77	158	86	−32	−9

* The "normal" figures up to the age of sixty-four are taken from insurance statistics by Symonds. The figures for sixty-five years and above are taken from a paper of Bowes. The latter are an average of only 46 cases.

high voltage x-ray machines showed an excess exposure on the dental films." This was in 1921.

BLOOD PRESSURE

Table I shows average blood pressure figures by single years of age up to the seventy-fourth year; also the number of smokers in each group and the approximate average number of hours per day and of years during which the questioned persons were engaged in active roentgenologic work and more or less exposed.

Table II gives the same data in a more condensed form for the purpose of comparison with "normal" average blood pressure figures calculated by Symonds from an enormous statistical material of more than 150,000 healthy men. In all groups the average figures obtained from the questioned roentgenologists are slightly lower than "normal," both systolic and diastolic. No characteristic difference in blood pressure was noted between the average of smokers and non-smokers. The influence of sex could be neglected as only two of the persons represented in the tables are females.

Twenty-seven (8 per cent) of the cases may be classified as "hypertensives" having a systolic pressure of more than 150 mm. Hg; 82 cases (24 per cent) had a systolic pressure below 120 mm. Fifty-nine per cent of the hypertensive and 61 per cent of the relatively "hypotensive" group are smokers. The average ages of both the hypertensives (fifty-six years) and the relatively hypotensives (fifty-four years) lay close together.

The average age at which an abnormally high systolic pressure had been discovered in the hypertensive cases was considerably lower, namely forty-nine years. While the blood pressure figures included in the tables were calculated from recent readings taken especially for answering the questionnaire, higher pressure levels had been observed previously in many instances (some of them after exertion). The maximum blood pressures ever recorded in the hypertensive individuals amounted to a total average of 189/114 against an average of 168/101 in the same cases as calculated from the figures which are given in Tables I and II.

There was no significant difference in the approximate total duration of "exposure" between the hypertensive and the hypotensive groups, their ratio being 1.0:1.1.

In 104 instances it was reported that beside gloves no protective appliances (aprons) were used on the body. The average age and the average blood pressure of these cases were practically the same as in those persons who did use aprons, etc. (Table III).

Table III

	Roentgenologists	
	Using Protective Aprons	Using No Aprons
Number of cases	240	104
Average age	54	54
Average systolic blood pressure	128 mm.	127 mm.
Incidence of anginal complaints on physical exertion	20 (8.3%)	7 (6.7%)
Incidence of coronary thrombosis	11 (4.6%)	5 (4.8%)

Findings in the urine

Ten persons reported the presence of traces of albumin in their urine, apparently due to nephrosclerotic changes. Five of these had a blood pressure higher than 150 mm. In one case a glomerulonephritis had been diagnosed forty-one years ago. Albuminuria was present and the blood pressure varied between 150/96 and 180/102 in this case. In 2 instances albuminuria was due to cystitis and pyelitis. Seven persons (2 per cent of the total number) were diabetics.

Peripheral arteriosclerosis

Arteriosclerosis of the peripheral vessels was reported in 23 persons, 16 of whom were smokers. Four of them had a blood pressure of more than 150 mm. The presence of peripheral arteriosclerosis was concluded from calcification visible on the roentgenogram in 7 cases; in the others apparently from palpatory impression. Only 1 person reported clinical signs of impaired peripheral circulation (dysbasia). Fifteen of these persons used protective aprons, etc., on their bodies, 8 did not.

Symptoms of cerebral hemorrhage were not reported in any instance.

Cardiac symptoms

Shortness of breath on exertion was reported as being slight in 31 cases (4 of them hypertensives) and as moderate to marked in 46 cases (6 of them hypertensives). However, it is very questionable whether this can be attributed mainly to cardiac factors, as emphysema, obesity, etc., may have been present in a number of instances. Two cases with shortness of breath obviously caused by pleural adhesions were not included.

More significant is the symptom of precordial oppression and pain on exertion as a criterion of coronary sclerosis combined with acute hormonal discharges from the suprarenal glands. It was reported in 27 instances (8 per cent). Seventeen of these were heavy smokers (more than 15 cigarettes or 5 cigars per day), 2 were moderate and 8 were non-smokers. Only 3 had a blood pressure higher than 150 mm.

Coronary thrombosis had been diagnosed in 16 cases and had been confirmed by the electrocardiogram in 13 of these. Ten were heavy smokers, 2 moderate and 4 non-smokers. Nine of these individuals complained also of anginal symptoms on exertion (see above).

Electrocardiographic findings recorded not earlier than within the past two years were reported in a total of 188 instances (Table IV).

Cardiac decompensation with congestive heart failure and attacks of pulmonary edema existed in 1 instance.

Cases with evidence of harmful exposure

In only a small group of cases was there any evidence of a harmful degree of exposure. These forms of excessive exposure dated far back, as in the older pioneers, or were only temporary, to be corrected soon after discovery of their results. The cardiovascular condition of these persons is shown in Table V.

TABLE IV

MANIFESTATIONS OF CARDIAC DISEASE IN ROENTGENOLOGISTS

	Number of Cases	
Slight dyspnea on exertion (cardiac origin?)	31	(incl. 4 hypertensives)
Marked dyspnea on exertion (cardiac origin?)	46	(incl. 6 hypertensives)
Precordial oppression and pain on exertion	27	(incl. 3 hypertensives)
Coronary thrombosis diagnosed	16	(electrocardiogram positive in 13)
Electrocardiographic changes other than those found in coronary thrombosis (188 findings):		
Left axis deviation	10	(incl. 2 hypertensives)
Auricular fibrillation	1	
Paroxysmal tachycardia	1	
Increased conduction time	1	
Atrioventricular block	1	
Changes of the S-T segment and the T wave and "myocardial damage"	7	
Congestive heart failure with pulmonary edema	1	

DISCUSSION

The only item of cardiovascular conditions, the estimation of which is possible by comparison with a large statistical material, is the blood pressure level.

Compared with the averages of healthy individuals as calculated by Symonds, the average blood pressure levels of 344 roentgenologists beyond the age of forty-five, including 27 cases of definite hypertension, were slightly lower than "normal" in all age groups up to the sixty-fourth year. In the higher age ranges from sixty-five to seventy-four years the tendency of roentgenologists to maintain a relatively low blood pressure level appears even more obvious in comparison with the figures given by Bowes for this age group.

This seems to confirm former observations made by Pfahler in his above mentioned inquiry of 1921. In his paper he comes to the following conclusions in regard to blood pressure:

> Accepting 120 mm. as normal for the age of twenty years, and adding 1 mm. for each two years above twenty as normal, there has been a general decrease in the systolic blood pressure. This has been the most constant abnormality found in these studies. The reduction varied from 5 to 38 points. In general there has been a reduction in systolic pressure of 10 to 15 points below normal. . . . The low blood pressure is too common to be ignored, but I believe that it is not caused by the radiation, because there are no other radiation effects corresponding, and it does not bear any relation to the amount of exposure, or the duration of service.

TABLE V

INDIVIDUALS WITH SIGNS OF INJURY FROM RADIATION

Age	Blood Pressure		Smoker	Hours of "Exposure" Per Day (at present)	Years of Roentgen-Ray Work	Manifestation of Injury from Radiation
	Systolic	Diastolic				
48	120	90	−	10	20	Anemia
48	130	80	++	?	17	Lymphocytosis (1933–1934)
48	150	95	+	5	16	Severe anemia, years ago
50	120	90	+	6	23	Exhaustion
60	125	75	++	8	31	Slight anemia
68	130	85	+	"all day"	43	Hands slightly injured
84	"Normal"		+	1–4	44	Hands severely injured

It is most likely caused by the high tension electric effects.

The figures assumed as normal by Pfahler are 5 to 7 mm. higher than those given by Symonds for the age groups of forty-five to sixty-four years.

If we wish to attribute any significance at all to the comparatively low average blood pressure levels found in radiologists, I still believe that an explanation could be attempted on the basis of the influence exerted by radiation upon the endocrine system as pointed out in the introduction. The depression of the blood pressure level might be regarded as the result of prolonged "spray" effects of roentgen rays partly on the adrenal glands and partly on the vessel walls themselves where the formation or liberation of adrenalin and its activation by sterols may be reduced in a similar way as it has been demonstrated concerning the secretory activity of the adrenal glands under direct roentgen treatment (Raab[27]). Large roentgen-ray doses are even apt to cause morphological changes in the suprarenal glands in experimental animals (Cottenot, David and Hirsch, von Decastello, Desjardins, Engelstad and Torgersen, Gabriel, Holfelder and Peiper, Martin, Rogers and Fischer, Tsuzuki).

The data concerning albuminuria and peripheral sclerosis are too few to allow a statistical evaluation. Considering the high percentage of smokers among the roentgenologists (29 per cent moderate, 38 per cent heavy) the presence of clinical signs of peripheral vascular disease (dysbasia) in only one case seems to indicate a relatively low incidence of this condition.

On the other hand, coronary disease both of the type of coronary thrombosis and of coronary stenosis with anginal complaints was reported in a relatively large number of cases which seems to justify the predictions of several of the questioned roentgenologists in regard to the outcome of this inquiry. As the majority of these cases were heavy smokers (63 per cent of the angina cases, 62 per cent of the thrombosis cases) and in view of the importance of tobacco smoking for the development of coronary sclerosis (English, Willius and Berkson, Strauss and others), it seems conceivable that an eventual protective effect of prolonged spray exposure to roentgen rays may have been wiped out by the toxic effects of nicotine in regard to the coronary arteries in a number of instances.

The presence of signs of congestive heart failure in only one of the actively working roentgenologists does not necessarily mean a low incidence of such a condition among members of this profession as most of those once afflicted with cardiac decompensation will probably have retired permanently from active work, thus dropping automatically out of these statistics. The same is true in regard to the completely negative reports concerning cerebral hemorrhage.

Attempts to obtain a larger number of statistical data concerning the causes of death of roentgenologists within the last three decades were unfortunately unsuccessful. However, a few scattered reports from individual contributors seem to indicate that death from cardiovascular disease is by no means uncommon among radiologists.

According to Dr. W. E. Reiley of Clearfield, Pennsylvania, 14 of 22 members of the Pennsylvania Radiological Society died from conditions belonging in this category: "Coronary," "cardiac" and "cardiorenal," one from "peripheral vascular disease." Three members of the same Society died from cerebral hemorrhage. A number of deaths from coronary thrombosis were mentioned in reports from New York, Texas, California, Michigan, Colorado, and elsewhere, at relatively early ages (about fifty). Excessive tobacco smoking among roentgenologists may have been a contributory factor.

Some of the roentgenologists who answered the questionnaire are also working with radium. Whether this has any specific influence cannot be said. Although modern protection equipment against roentgen rays and radium was reported as being in use at present in all instances, there were indica-

tions of damage to skin and blood in 7 persons. None of these cases had a blood pressure above 150 mm. or other signs of cardiovascular disease. The use or avoidance of protective aprons did not seem to make an essential difference as far as cardiovascular changes were concerned.

SUMMARY

The answers given on a written questionnaire by 344 American and Canadian roentgenologists beyond the age of forty-five years suggest a blood pressure level slightly below normal in all age groups. Also peripheral vascular disease of a major degree and severe nephrosclerosis seemed to be relatively uncommon.

The incidence of coronary disease, on the contrary, was found high, both without and with thrombosis. The majority of persons suffering from these conditions were heavy smokers.

Whether or not the results concerning blood pressure and peripheral vascular disease are attributable to prolonged roentgenray "spray" effects upon the cardiovascular system cannot be decided due to the variety of complicating factors. However, they at least do not seem to be incompatible with the working hypothesis that prolonged exposure of the entire body to minute roentgen doses may exert a certain protective effect against an exhausting and ultimately destructive overactivity of the suprarenal hormones and related substances within the myocardial and arterial muscular tissues.

I wish to express my appreciation to all those who made this survey possible by filling out and returning the questionnaire and by giving other valuable information and advice.

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THE SIGNIFICANCE OF PSAMMOMA CALCIFICATION IN THE ROENTGEN DIAGNOSIS OF PAPILLARY TUMORS OF THE OVARY*

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CALCIFICATION or ossification is occasionally found in the ovary and its presence, demonstrated roentgenographically, may aid materially in the diagnosis of some ovarian lesions. The roentgen appearance of dermoid cyst has received much attention in the literature and there are many excellent papers describing the characteristic roentgen findings in such cases.[8,15,22] Other conditions of the ovary which may exhibit calcification or ossification, however, have received little attention in the roentgen literature, in spite of the fact that the particular type of calcification produced by some of these lesions may be of great diagnostic importance.

Various authors have described calcification or ossification on pathological examination of the following ovarian lesions: fibromata,[19,20] sclerosis of the ovary,[19] ovarian cyst,[18,19] corpus albicans,[1,18,19] complete ossification of the ovary,[12,14,16,17,18,21,23,24] bone of unknown etiology,[3,4] papillary cystadenoma and papillary cystadenocarcinoma.[2,5,7,9,10,13]

This paper deals with the last two of the above conditions, namely, the diagnosis of papillary tumors of the ovary based on the finding of psammoma calcification by roentgen examination of the abdomen.

The occurrence of this particular type of calcification (psammoma bodies) is practically limited in the abdomen to the two papillary neoplasms of the ovary mentioned above, namely, the benign cystadenoma and the more malignant form of the same tumor, the papillary cystadenocarcinoma. Kaufmann[9] states that: "Very frequently, calcific granules, the so-called psammoma bodies, are found in papillary cysts (of the ovary), while they are very uncommon in simple cystadenomas. In places the papillae may feel sandy. These psammoma bodies (corpora amylacea) are composed of calcium carbonate in an organic framework, built up concentrically; they look like mulberries, or have an even contour; they are found in the connective tissue of the cyst wall as well as in the papillae." Adami and Nichols[2] state that: "In papillary cystoma it is not uncommon to find granules of lime (sand bodies, psammoma) in the wall and in the papillae. In the papillary type of carcinoma (of the ovary) as in the benign form (papillary cystadenoma) psammoma may occur."

In 1936, Loud[11] reported a case of multilocular papillary cystadenoma of the ovary in which he was able to prove a recurrence of the tumor by demonstrating psammoma calcification roentgenographically. His report is the only one to be found in the American literature dealing with the roentgen diagnosis of this condition based on the findings of psammoma calcification. Our experience with the following 5 cases during a period of three years leads us to believe that the roentgen appearance of this particular type of calcification is quite characteristic and that its demonstration roentgenographically in many cases may permit a histopathological diagnosis of papillary cystadenoma or papillary cystadenocarcinoma of the ovary.

REPORT OF CASES

CASE 1 (No. 125283). An American housewife, aged fifty-eight, was admitted to the Massachusetts General Hospital for roentgen therapy following an exploratory laparotomy at another hospital. The operative report stated

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Fig. 1. Case 1. Psammoma calcification in a papillary cystadenoma or cystadenocarcinoma of the ovary.

that the abdomen had contained a large quantity of fluid. A tumor resembling an ovarian cyst had been found in the region of the right ovary. This was evacuated, disclosing firm tumor tissue in its posterior portion. A large cystic mass was also found in the region of the left ovary, with tumor tissue extending downward to involve the rectum. The omentum was markedly thickened and there were multiple adhesions throughout the lower abdomen and pelvis.

A biopsy from the firm mass between the left ovary and rectum was reported as follows: "Section through material from the pelvis shows it to consist of rather broad papillary projections having loosely arranged, moderately vascular, edematous connective tissue base covered with a low columnar epithelium which in many places is heaped up. At several points near the surface and in the lymph nodes there are small calcified nodules resembling psammoma bodies. The picture is definitely that of a benign papillary adenocystoma or, if a malignant one, it is growing extremely slowly. The condition of the omentum suggests that there have already been small implants."

A plain film of the abdomen (Fig. 1) taken before the institution of roentgen therapy showed a large area of hazy, amorphous calcification, 15 cm. in length, extending obliquely across the true pelvis from the ischial spine on the left to the sacroiliac joint on the right. The margins of this shadow were ill defined and irregular and the density was considerably less than the density of calcified glands or other calcifying lesions in the abdomen.

From May 2 to June 13, 1938, the patient received 200 kv. roentgen therapy through oblique portals covering the lower abdomen and pelvis, with a total surface dosage of 6,000 r (measured in air).

The condition responded unusually well to the roentgen therapy. The pelvic masses became markedly reduced in size and a film taken elsewhere (Fig. 2) on June 27, 1940 (two years later), shows that the areas of calcification in the pelvis are reduced in size and increased in density. It would appear that the psammoma calcification has not been completely absorbed but that the psammoma bodies have become more closely grouped due to the shrinkage of the supporting neoplastic cells as a result of roentgen therapy. There has been no reaccumulation of fluid and the patient has led a normal life for the past two years.

Fig. 2. Case 1. The same patient two years after roentgen therapy. The areas of calcification are reduced in size and increased in density.

Case II (No. 162548). An American woman, married, aged fifty-six, entered the hospital because of loss of 70 pounds in weight during the past eighteen months. Her only other symptoms were dysuria and frequency of three to four years' duration. Her physical examination was essentially negative except for some enlargement of the thyroid and a large mass in the left side of the pelvis. This mass appeared to be intimately associated with and attached to the uterus and its consistency suggested a fibroid. There was also a soft cystic tumor adherent to the uterus on the right side.

At operation there was no fluid in the abdomen. The pelvis was a frozen mass consisting of three major portions, one a small cyst about the size of an orange on the left side, second a large cyst measuring 7 inches in diameter on the right side, and third a mass about 3 to 4 inches in diameter made up of cyst and solid tumor which was densely adherent to the uterus and left pelvic wall. All the masses were removed with some difficulty and a supravaginal hysterectomy performed.

On pathological examination the specimen was found to consist of three pink-yellow, multilocular cystic masses measuring 6, 4 and 3 cm. in diameter, each of which contained numerous cysts measuring up to 2 cm. in diameter, and all containing serous fluid. On the surface of one of these cysts there were irregular calcified plaques. The largest contained a solid area of white, nodular, fibrous tissue the nodules of which were partially calcified.

Sections of the ovarian lesions show numerous cystic cavities lined by single layers of well differentiated columnar epithelium. Intervening between the cysts is an abundance of dense fibrous connective tissue without characteristic features. Scattered among the collagen fibers are flecks of calcium deposit (psammoma bodies), several of which have a laminated structure. There is no histologic suggestion of malignancy. Diagnosis: multilocular cystoma of the ovary.

The patient made a good postoperative recovery and was discharged free of symptoms. She was readmitted to the hospital two years later, however, with the history of having been in good health until three months previously when she developed frequent sharp cramping pains throughout the abdomen and low back. This was associated with nausea, anorexia, and constipation. Four days before entry, the pain became a steady, dull ache over the entire abdomen with occasional sharp cramps. She vomited a large quantity of fluid and she had had no bowel movement for two days.

Fig. 3. Case II. Intestinal obstruction due to extensive peritoneal metastasis from papillary cystadenocarcinoma of the ovary. Note the wide distribution of the psammoma calcification.

A plain film of the abdomen at this time (Fig. 3) showed numerous large and small areas of amorphous calcification throughout the pelvis and abdomen. The largest of these shadows, measuring 15×5.5 cm. in diameter, occupied the pelvis. Another area of calcification, 9×4 cm., lay in the right upper quadrant beneath the lower border of the liver, and there were numerous smaller nodules along the right side of the abdomen and in the left upper quadrant. There were also a number of dilated, gas-filled loops of small bowel, forming a stepladder pattern in the mid-abdomen. A diagnosis of abdominal carcinomatosis due to papillary cystadenocarcinoma of the ovary with small intestinal obstruction was made and operative measures were undertaken to relieve the obstruction.

The abdomen was opened through a paramedian incision and extensive carcinomatous masses were found scattered widely over the peritoneum. The terminal ileum was found to be obstructed in the bottom of the pelvis in a

Fig. 4. Case III. Abdominal carcinomatosis. Pathological diagnosis: papillary cystadenocarcinoma of the ovary with very extensive psammoma calcification.

mass of carcinoma, and another mass about the size of a fist was producing obstruction at the hepatic flexure of the colon. All loops of bowel not covered with implants were covered with white fibrinous material and much of the bowel was densely adherent in masses of malignant tissue. A side to side ileotransverse colostomy was done with a loop of ileum just above the obstruction. A specimen was removed for biopsy and the abdomen closed. The pathological report of this specimen was as follows:

The lesion bears little resemblance to the original process described. There are numerous clusters of small columnar epithelial cells with acinar and papillary arrangement. Mitotic figures are sparse. An intervening stroma of connective tissue is apparent. Among and in great part replacing many of the acini are concentrically laminated granules of calcified material (psammoma bodies). These are much more abundant than the flecks of calcium noted in the original specimen. Diagnosis: papillary cystadenocarcinoma.

The patient made an uneventful postoperative recovery and was discharged from the hospital following an intensive course of roentgen therapy.

Case III. An American woman, single, aged thirty, was admitted to a psychiatric institution where she remained until her death twenty years later. Her past history revealed that at the age of nineteen the patient had shown a definite change in behavior. She at times became hysterical, seclusive and cried a great deal. Her mental condition became progressively worse, she lost all interest in things she previously liked and she refused to answer when spoken to. At the age of twenty-one, a panhysterectomy and oophorectomy were performed in another hospital without change in her mental condition. This was followed, however, by a gain of 100 pounds in weight. On admission to the hospital, her physical and neurological examinations were negative and a psychiatric diagnosis of schizophrenia was made. She showed marked mental deterioration at this time which slowly progressed until her death twenty years later. Her physical health during most of this time, however, remained excellent. Twelve years after admission (1932) the patient acted as if she had pain and tenderness in the gallbladder region and the stools were clay colored. A Graham test at this time showed no visualization of the gallbladder. Plain abdominal films showed small areas of calcification overlying the left kidney and in the lower abdomen. These shadows were small and were thought to represent calcified mesenteric glands.

Seven years later, during the course of a routine physical examination, an abdominal mass about 5 cm. in diameter was noted in the right lower quadrant. Subsequent examinations revealed many stony hard masses throughout the abdomen and in the pelvis on rectal examination. Roentgen examination at this time was difficult because of the lack of cooperation by the patient. The films, however (Fig. 4), showed a marked change since the previous examination. Multiple, unusually large calcified masses were present throughout the abdomen. The largest of these, measuring 6×19 cm. in size, lay obliquely across the mid abdomen immediately beneath the transverse colon. Another area of calcification 3×10 cm. in size formed the upper border of a soft tissue mass in the mid pelvis. Another lobulated mass, resembling a partially calcified stag-horn calculus, lay above and lateral to the left kidney, and there were a number of smaller, calcified areas scattered between

the larger masses. All these areas of calcification were sharply defined but their density was not great considering their size, so that it seemed reasonable to suppose that the calcium was deposited in small particles diffusely throughout tissue of normal soft tissue density. The diagnosis was very much in doubt. Calcification in papillary adenocarcinoma of the ovary with extensive abdominal metastasis was considered, but rejected since the patient had had a bilateral oophorectomy twenty-eight years previously.

The patient's condition remained unchanged until about six months before death when she began to seem weak and to move as though she had abdominal pain and tenderness. She later showed signs of fluid in the right pleural cavity, grew rapidly weaker and died.

At postmortem, the peritoneal cavity was obliterated by dense fibrous adhesions, and seeded on both the parietal and visceral peritoneum there were numerous metastatic nodules measuring 1 mm. to 5 cm. in diameter. These nodules were moderately firm and many were cystic, being filled with opaque, yellowish caseous material. Others were grayish-white and yellow on section, granular in consistency and containing numerous tiny flecks of calcified material. A large mass, 10×5×8 cm. in size, extended from the transverse colon to the parietal peritoneum, infiltrating these structures as well as the anterior abdominal wall. The right lobe of the liver was almost completely encased by a 5 to 10 mm. layer of fibrous tissue and metastatic tumor. On section, however, there were no nodules in the liver.

The gallbladder, containing eight faceted calculi, was almost encased by a mass 10 cm. in diameter which infiltrated its wall. The spleen on section contained numerous scattered nodules up to 2 cm. in diameter. The pelvic structures were completely matted together to form a mass, 15×10×10 cm., the individual nodules of which measured up to 6 cm. in diameter. Serial sections revealed no evidence of uterus, tubes, or identifiable ovaries. The mass was adherent to and infiltrated the wall of the rectosigmoid and there was a nodular tumor 5.5 cm. in diameter in this region which might have represented the residuum of the left ovary.

Sections from various lesions all showed essentially the same structure. The architecture was frankly papillary in character, the fronds being composed of short stumpy columnar epithelial cells with thin cores of loosely arranged collagen. There was occasional abortive acinus formation but mitotic figures were not observed. There were enormous numbers of laminated concretions of calcium (psammoma calcification). Much of the tumor was encapsulated and even infiltrated by dense connective tissue. In several regions there was apparent growth into lymphatic and venous channels.

Fig. 5. Case IV. Extensive psammoma calcification in a case of papillary cystadenocarcinoma of the ovary.

The histopathological appearance was characteristic of papillary cystadenocarcinoma of the ovary. How this tumor arose is still a mystery, considering the history of a bilateral oophorectomy twenty-eight years previously. It is possible that the surgeon did not actually remove both ovaries at that operation or, if he did, that there was accessory ovarian tissue elsewhere in the abdomen.

Case IV (No. 255436). A housewife, Irish, aged fifty-eight, felt well until six weeks before admission to the hospital. At this time she developed a dull ache in the suprapubic region which was accentuated by voiding. She also noticed a gradual increase in size of her abdomen and a loss in weight in spite of the abdominal enlargement. There was also some weakness and lassitude.

On physical examination, the abdomen was found to be distended with fluid and no masses were palpable.

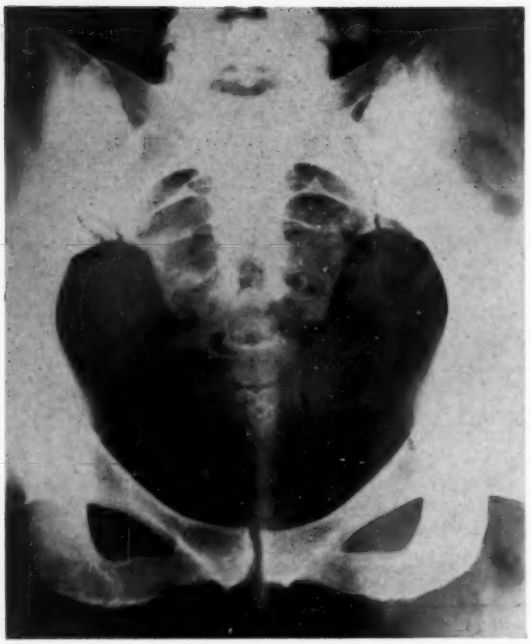

Fig. 6. Case v. Minute areas of calcification in a very early papillary cystadenocarcinoma of the ovary.

Roentgenograms of the abdomen (Fig. 5) showed diffuse haziness of the abdominal structures due to the presence of fluid. There were multiple, large, ill-defined areas of hazy, amorphous calcification scattered throughout the abdomen. The largest mass lay in the right upper quadrant just above the hepatic flexure of the colon and similar smaller areas were seen along the left side of the abdomen and in the mid pelvis. The findings were considered characteristic of papillary cystadenocarcinoma with extensive metastases throughout the peritoneum, and this roentgen diagnosis was confirmed by peritoneoscopy. This patient received an intensive course of roentgen therapy and it is as yet too early to evaluate the results.

The 4 cases reported represent far advanced cases in which there is no difficulty in diagnosis if one bears the condition in mind. It is possible, however, that the roentgen demonstration of minor degrees of psammoma calcification in the very early cases may be of great assistance in early diagnosis and may lead to prompt surgical treatment before the condition has advanced. The following case is not a perfect example since the carcinoma was extremely early and there were only traces of calcium in it, insufficient to warrant a definite diagnosis. The possibility of papillary cystadenocarcinoma was suggested by the roentgenologist, however, on the basis of the calcification observed on an intravenous pyelogram and this diagnosis proved to be correct on histopathological examination.

Case v (No. 237741). An American housewife, aged forty-two, entered the hospital because of right sided lower abdominal ache of one month's duration. She had no other symptoms and her menstrual periods had been normal. The general physical examination revealed nothing abnormal but on pelvic examination a smooth, rounded tumor was found behind the cervix. This was tender to touch and reproduced the type of pain of which the patient complained.

Roentgen examination by plain abdominal films and intravenous pyelography revealed no abnormalities in the urinary tract. There was, however, a group of minute areas of calcification in the left side of the pelvis near the ureteropelvic junction (Fig. 6). These shadows were outside the ureter and bladder and they appeared to be in the central portion of a small soft tissue mass just to the left of the uterus. The conclusions were that these areas of calcification could be in a fibroid of the uterus but that papillary cystadenocarcinoma of the left ovary was also a possibility.

At operation, the uterus was found to be moderately enlarged and there were many, fine, pinpoint, cystic areas studded over both tubes, ovaries and the posterior surface of the uterus. The ovaries were abnormal in appearance, being hard and sclerotic. A total hysterectomy and bilateral oophorectomy was therefore performed.

On pathological examination the uterus was normal. The right tube measured 8.5 cm. and along its entire extent it was studded with gray-white and clear, cyst-like nodules measuring 1 to 3 mm. in diameter. The nodules were also scattered over the fimbria and the ovary, where they occurred in great numbers, giving the ovary a somewhat granular appearance. There were three large, clear cysts attached to the ovary. The cut surface of the ovary was firm, containing many various sized, clear gray-white cysts. The left ovary and tube were similar in appearance.

Sections from both ovaries showed numerous small cysts, especially in the immediate subperitoneal zone which were lined with atypical epithelium of varying type which could not be interpreted as belonging to follicular development. In numerous areas psammoma bodies were found, some of which were immediately connected with the atypical acini. At one point in the center there were papillary processes covered with the same atypical epithelium and there was definite extension of the process to the tube.

Conclusions: The pathological findings represent an extremely early stage in the development of malignant papillary cystadenoma.

In reviewing these cases we have been impressed with how characteristic psammoma calcification often is roentgenographically. The density of the partially calcified masses is the most striking feature. The characteristic density is less than that of most calcifying conditions of the abdomen. The psammoma bodies being extremely minute, and being fairly uniformly distributed throughout the neoplastic mass, produce a hazy shadow which is often only slightly more dense than the normal soft tissues. Other masses of the same tumors, however, may show a much greater degree of calcification resulting in bizarre shadows with sharply defined margins whose density approximates that of calcium stones in the kidney.

The second unusual feature of psammoma calcification in some of these cases is its remarkable extent. In no other condition of the abdomen have we observed so much calcification. The partially calcified masses have filled the pelvis and multiple large and small calcifying masses have been found throughout the entire abdomen. When the process is as extensive as this, there is no other condition with which it can be confused. Smaller masses, however, must be differentiated from other calcifying lesions of the abdomen.

Calculi in the kidneys, ureter, or bladder can be eliminated in the differential diagnosis by pyelography. Calculi in the pancreas can be localized by barium in the stomach and duodenum. Mesenteric glands are usually more sharply defined and denser than the characteristic psammoma calcification and this is also true of fibroids of the uterus. The calcification in benign cysts of the ovary is more often crescentic or circular, the calcification forming large plaques in the walls of the cysts.

The roentgen shadow most closely simulating psammoma calcification is the fine coating of barium, frequently observed adhering to the mucosa of the colon several days after a gastrointestinal examination. In Case III, the roentgenologist, on viewing the plain abdominal films for the first time, assumed that the area of density across the abdomen represented barium or bismuth in the transverse colon. Proof that it represented an unusually large, partially calcified mass outside the colon was easily afforded, however, by a roentgen examination after barium enema.

In conclusion, it must be emphasized that although the calcification in parts of the tumor may be of great density and may simulate the calcification observed in many other lesions of the abdomen, the diffuse, hazy calcification of other parts of the tumor is the diagnostic feature. It is hazardous to make a diagnosis of papillary cystadenoma or papillary cystadenocarcinoma simply on the presence of calcification in a tumor. Only the diffuse, hazy type of calcification characteristic of psammoma bodies is diagnostic of papillary tumors of the ovary.

SUMMARY

Although calcification may occur in many lesions of the ovary, psammoma calcification is practically limited to two conditions: papillary cystadenoma and papillary cystadenocarcinoma.

Five cases of psammoma calcification have been presented in which this type of calcification was demonstrated on roentgenographic examination of the abdomen. It is believed that the type and extent of calcification in four of these cases were sufficiently characteristic to justify a roentgen diagnosis of papillary cystadenocarcinoma of the ovary.

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THE MENISCUS-COMPLEX IN THE ROENTGENOLOGIC DIAGNOSIS OF ULCERATING CARCINOMA OF THE STOMACH*

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IN 1921, Carman described a new roentgenologic sign that he considered pathognomonic of ulcerating carcinoma of the stomach. The lesions that he had specifically in mind were the small, predominantly ulcerous carcinomas; the craters of these carcinomas ranged in diameter from 3 to 8 cm., had more or less elevated, sometimes overhanging borders and little tendency to burrow into the gastric wall. These pathologic characteristics not only served to distinguish the lesions morphologically from benign and malignant ulcers, but also furnished a substantial basis for Carman's study and conclusions.

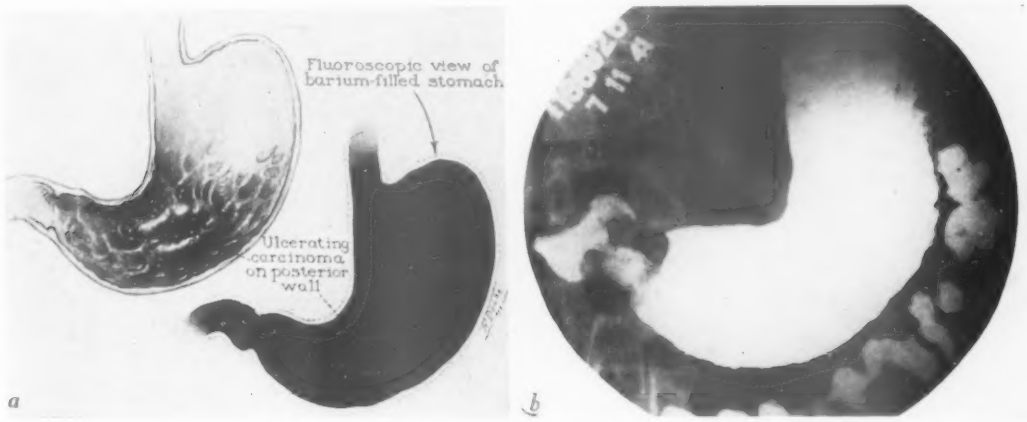

FIG. 1. *a*, schematic drawings of ulcerated carcinoma on posterior wall of stomach with fluoroscopic appearance; *b*, ulcerated adenocarcinoma on posterior wall of stomach; the halo surrounding the elliptical crater may be noted.

At the time Carman wrote, roentgenologic examinations usually were made only after the stomach was largely filled with the suspension of barium. Carman warned that roentgenoscopic inspection with manipulation was necessary in order to disclose the lesions, for they were not likely to be exhibited if roentgenograms alone were made. With the roentgenoscopic technique, Carman noted that when the carcinoma was on the posterior wall well away from the lesser curvature, pressure would reveal the barium-filled crater as a dense spot surrounded by a lighter zone, or halo, produced by the encircling ridge (Fig. 1, *a* and *b*). When the lesion was on or near the vertical portion of the lesser curvature, pressure caused the crater to appear as a crescentic shadow with its convexity directed toward the curvature (Fig. 2). When the carcinoma was on the lesser curvature distal to the angle of the stomach and was several centimeters in diameter, the base of the crater followed the bending line of the curvature and was concave (Fig. 2). In most instances the form of the barium-filled crater resembled a lens seen edgewise so strikingly that Carman called his discovery the "meniscus sign." He also directed at-

* Read at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

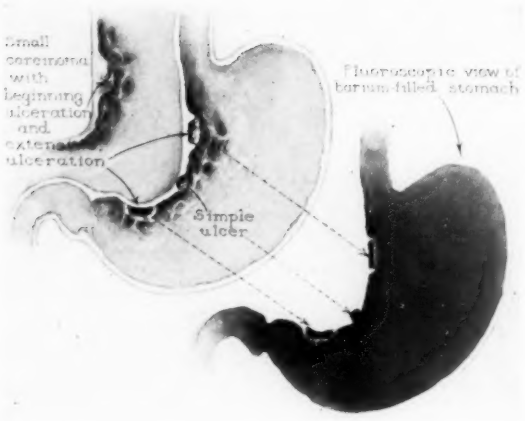
Small carcinoma with beginning ulceration and extensive ulceration
Fluoroscopic view of barium-filled stomach
Simple ulcer

Fig. 2. Schematic drawings of a small ulcerated carcinoma and a gastric ulcer with fluoroscopic appearance.

tention to two other features as follows: (1) the crater did not project into the wall of the stomach, at least not markedly, but was entirely or mostly intraluminal rather than intramural, and (2) when the crater had overhanging walls, it was more or less difficult to empty by manipulation.

As I had the opportunity of working with Carman for a time, I was impressed with the soundness of the principles of his observations and began to employ the meniscus sign as a diagnostic criterion. With increased experience, I realized that the shape of the ulcerous crater was not significant, as the form depicted was partly an effect of manipulation. The really significant features were the elevated border of the

Fig. 3. *a*, intraluminal ulcerated lesion at the angle of the stomach; *b*, (same case as *a*) spot roentgenogram depicting a typical meniscus-complex; *c*, (same case as *a* and *b*) specimen; pathologic report was Grade 2 ulcerated adenocarcinoma.

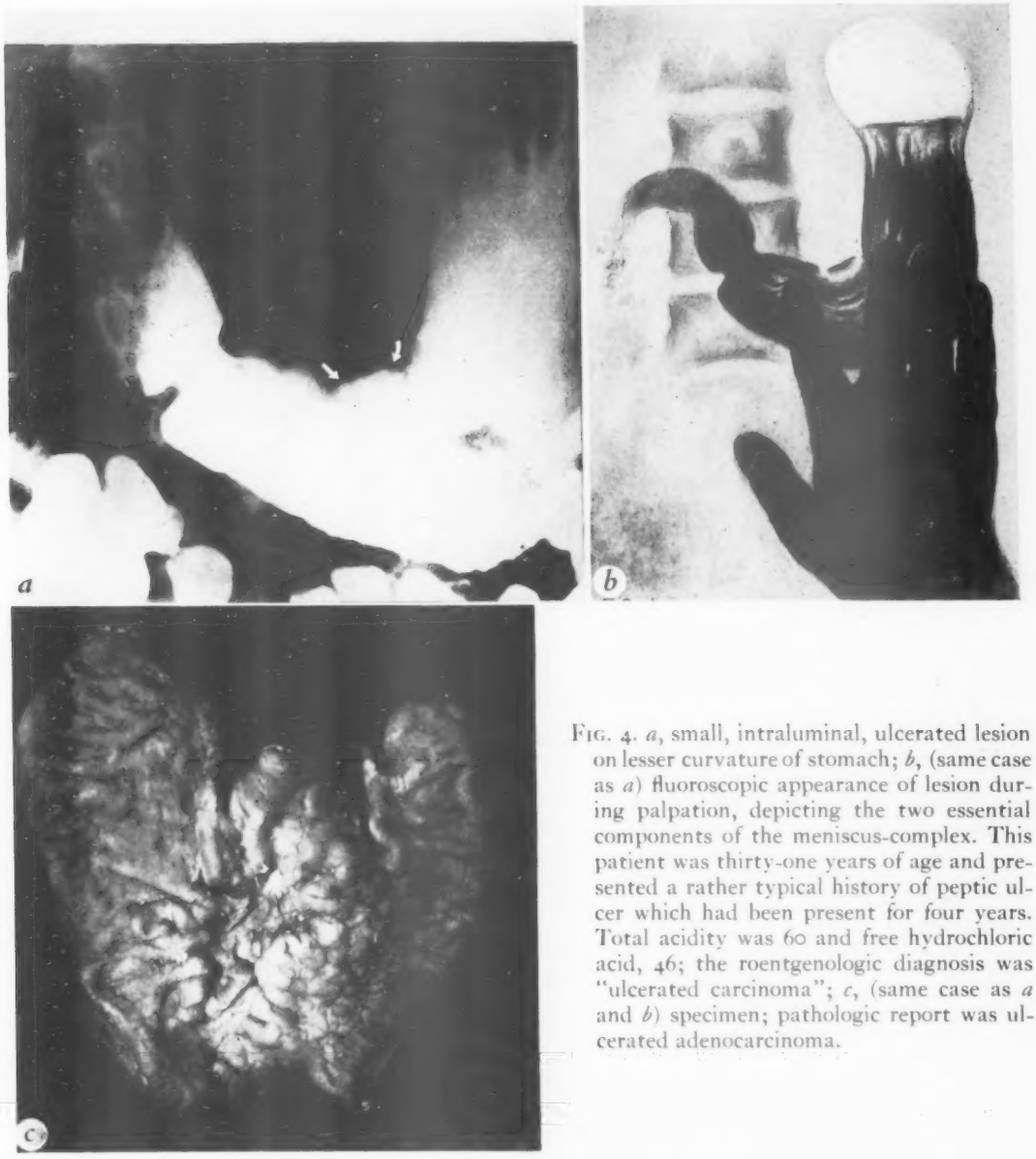

Fig. 4. *a*, small, intraluminal, ulcerated lesion on lesser curvature of stomach; *b*, (same case as *a*) fluoroscopic appearance of lesion during palpation, depicting the two essential components of the meniscus-complex. This patient was thirty-one years of age and presented a rather typical history of peptic ulcer which had been present for four years. Total acidity was 60 and free hydrochloric acid, 46; the roentgenologic diagnosis was "ulcerated carcinoma"; *c*, (same case as *a* and *b*) specimen; pathologic report was ulcerated adenocarcinoma.

ulcerous cavity and the fact that the crater did not extend into the gastric wall but was based on the inner aspect of the wall. Thus, it became clear to me that Carman had presented all the factors in his sign, which was really a sign-complex, but had emphasized one of the less essential features.

With this amendment I have employed the meniscus-complex for many years with thoroughly satisfactory results and have repeatedly recommended it as a reliable index. My associates in the Section on Roentgenology of the Mayo Clinic and other roentgenologists also have proved the trustworthiness of the complex by trial. However, doubts as to its reliability have been expressed occasionally, and these doubts evidently have arisen from misconceptions of the syndrome. Furthermore, I feel that I may have contributed to the misunderstanding by failing to emphasize the two essential factors in the complex. For

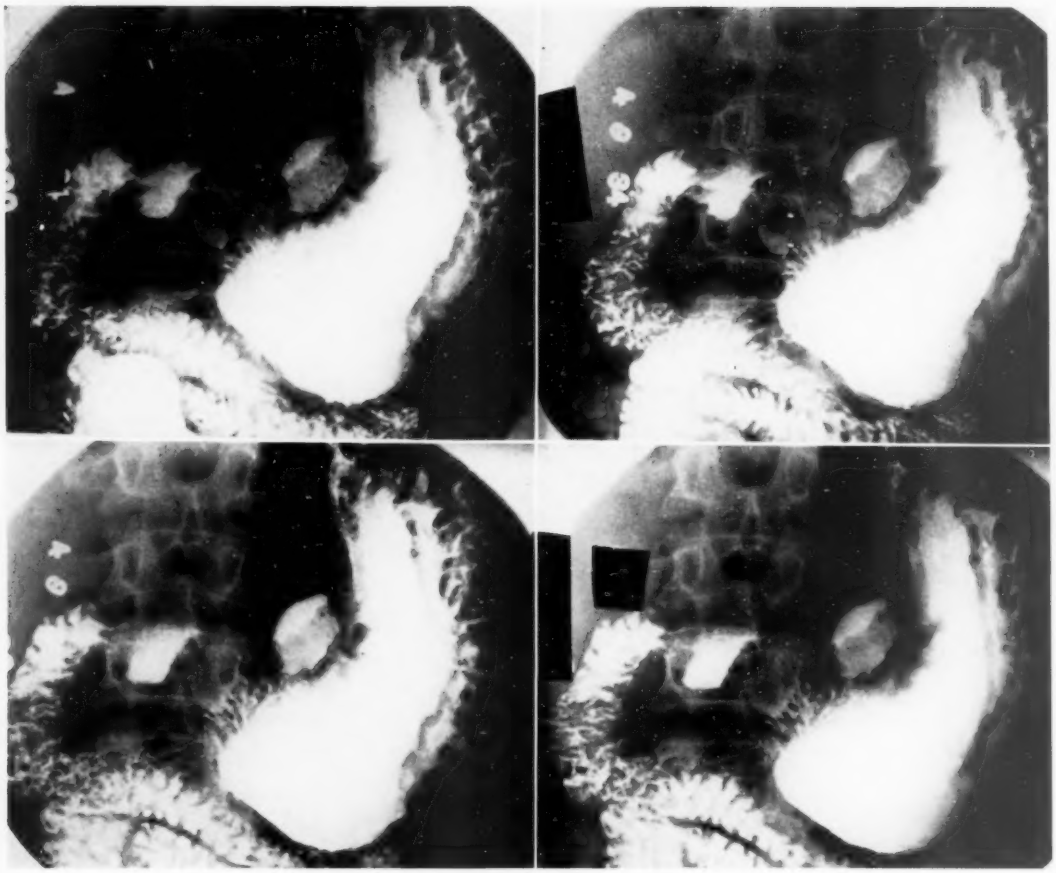

Fig. 5. Large, benign, gastric ulcer with induration encircling it. The induration produces a halo but this must not be confused with or interpreted as a meniscus-complex for the crater is extraluminal and hence cannot be a meniscus-complex.

these reasons, and because I feel that this sign-complex is too valuable to be disregarded, I have chosen to review the subject.

FACTORS IN DIAGNOSIS

Of the two factors in the complex, the tumefied border of the crater ranks first in importance, because without it the other factors would seldom exist and because localized tumefaction of the gastric wall most often is attributable to carcinomatous neoplasia. The tumefaction varies in height and width; usually, it is fairly uniform in these respects and encircles the crater completely, although in exceptions the tumefaction is irregular or limited to a portion of the rim of the ulcerated portion. The encircling ridge produces, under pressure, the transradiant halo around the crater when the lesion is on the posterior wall of the stomach. When the small ulcerating carcinoma is on the lesser curvature, as most of these lesions are, the dependent portions of the ridge, if it is high or undermined, can be approximated by pressure so as to produce a transradiant arc that separates the barium in the crater from that in the stomach (Fig. 3, *a*, *b* and *c*, and 4, *a*, *b* and *c*). Circumvallate tumefaction alone, however, is not pathognomonic of ulcerating carcinoma because gastric ulcers occasionally have swollen, slightly elevated borders and because callous ulcers, which are rather rare, are surrounded by a definite ridge of scar tissue (Fig. 5).

The second factor essential to the complex is the intraluminal situation of the

Fig. 6. *a*, pyloric portion of stomach showing hypertrophic rugal folds above pylorus; *b*, (same case as *a*) spot roentgenograms depicting barium pent up between hypertrophic folds of mucosa producing a picture resembling the meniscus-complex.

crater, which is not sculptured in the gastric wall, or at least does not penetrate deeply into the wall, but has its deepest part on or near the mucosa. In other words, the entire lesion, including the crater, forms a bas relief on the internal surface of the stomach (Fig. 2). At first thought it might seem difficult to determine whether the crater is in the wall or not, for the normal luminal contour is interrupted by the carcinoma. When the lesion is on the lesser curvature, the examiner is obliged to estimate what the normal profile of the lumen should be at that point. However, the question is not hard to decide from the relative positions of the shadows. When the carcinoma is on the posterior wall of the stomach, as Carman pointed out, the crater is not visible at any tangential view as a prominence on the silhouette of the stomach. It is the intraluminal situation of the crater that distinguishes ulcerating carcinoma of the morphologic variety considered in this paper from gastric ulcer, the crater of which has burrowed into the gastric wall. This criterion is indispensable in distinguishing callous ulcer from ulcerating carcinoma (Fig. 5).

Evidence that an intraluminal situation of the crater is essential to the complex was presented by Freedman and Goehring, who stated that the meniscus sign may occur in benign as well as malignant lesions. In proof, they cited a case in which a benign

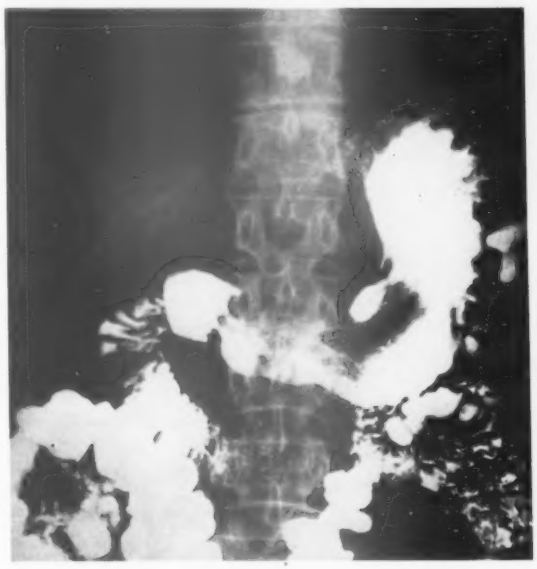

Fig. 7. Gastric ulcer which has perforated into the pancreas producing an accessory pocket surrounded by indurated, inflammatory tissue. This roentgenogram and the fluoroscopic findings were misinterpreted as a meniscus-complex. A tangential view was not obtained. The lesion was benign.

ulcer with raised and undermined edges was diagnosed as ulcerating carcinoma on the basis of what they considered to be a typical meniscus sign. In the illustrative roentgenogram, however, it was obvious that the crater had burrowed deeply into or through the gastric wall, and thus, the second component of the complex is lacking. Apparently Freedman and Goehring assumed that tumefaction of the border of the ulcer alone was sufficient to constitute the meniscus sign. Among their references they listed two of my papers, in one of which I described both elements of the complex and in the other, incidental to a general discussion of carcinoma of the stomach,[3,4] I stressed the significance of the ridge but did not mention the situation of the crater.

Only two simulants of the meniscus-complex have come under my observation, and neither of them is very deceptive. One is produced by barium pent up between two hypertrophic rugal folds near the lesser curvature (Fig. 6, *a* and *b*); in such instances the existence of similar rugae parallel to those enclosing the barium should identify the condition. The other potential imitator of ulcerating carcinoma is peptic ulcer on the posterior wall, in this condition the crater may have a more or less elevated border (Fig. 7). Thus the lesion may be mistaken for carcinoma if the examiner fails to demonstrate an intramural protruding niche by turning the patient so as to obtain a favorable tangential view.

Not all ulcerating carcinomas give rise to the complex, for some of them have craters

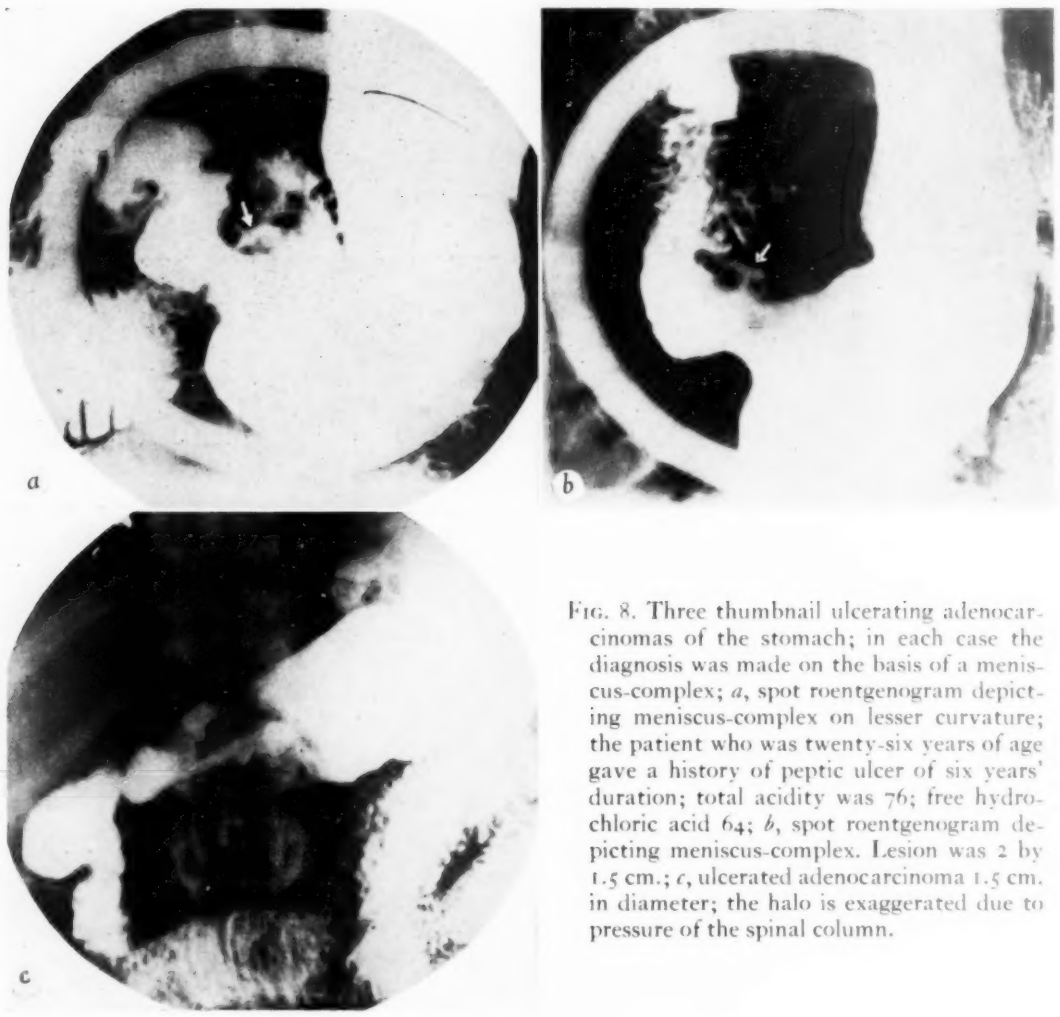

Fig. 8. Three thumbnail ulcerating adenocarcinomas of the stomach; in each case the diagnosis was made on the basis of a meniscus-complex; *a*, spot roentgenogram depicting meniscus-complex on lesser curvature; the patient who was twenty-six years of age gave a history of peptic ulcer of six years' duration; total acidity was 76; free hydrochloric acid 64; *b*, spot roentgenogram depicting meniscus-complex. Lesion was 2 by 1.5 cm.; *c*, ulcerated adenocarcinoma 1.5 cm. in diameter; the halo is exaggerated due to pressure of the spinal column.

that penetrate deeply into or through the gastric wall. It should be unnecessary to say also that the complex has no relation to malignant ulcer, a term of convenience applied, mostly by roentgenologists, to a carcinomatous lesion that morphologically is an ulcer with an intramural crater and without macroscopically visible neoplasia, although such ulcers can properly be classified pathologically with ulcerating carcinomas.

ogist, and all concerned are surprised at the accuracy of the roentgenologic diagnosis (Fig. 8, *a*, *b* and *c*, and 9, *a* and *b*).

In view of the facts, I feel that my confidence in the meniscus-complex is fully warranted, and I hope that this review will clear up any misunderstanding that may exist. When clearly understood, the index affords an extraordinarily efficient and practicable means of identifying the "thumbnail" carcinomas that often are mis-

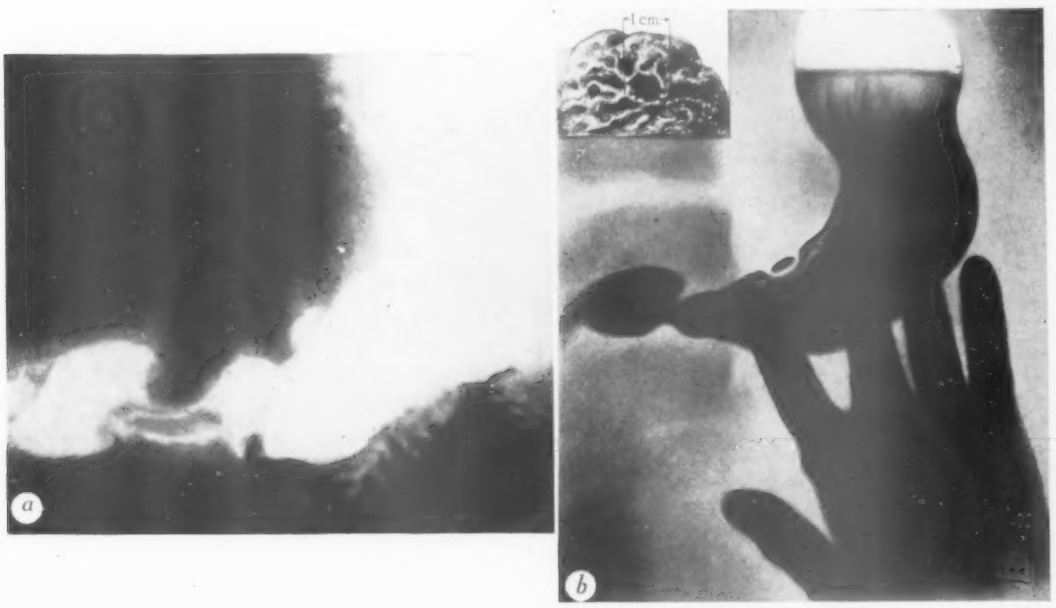

Fig. 9. Small ulcerating adenocarcinoma of the stomach; *a*, small, intraluminal ulceration on lesser curvature below the angle (1 cm. in diameter); *b*, (same case as *a*) drawing depicts fluoroscopic appearance of meniscus-complex.

No one can reasonably contend that any roentgenologic sign is absolutely infallible. Certainly the examiner who determines whether a sign or complex exists in a given instance may err in his judgment. Despite these inescapable limitations, the meniscus-complex has proved in my experience to be as reliably pathognomonic as any index with which I am acquainted. I have found it to be especially valuable in identifying small ulcerating carcinomas, some of which are only 1 to 1.5 cm. in diameter. Often in such cases the history elicited by the clinician is typical of peptic ulcer, the gastric acidity is normal or high, the lesion appears grossly benign to both surgeon and pathol-

taken for benign ulcers or are overlooked completely.*

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* For discussion see page 582.

A STELLATE IMPRESSION IN THE CARDIAC END OF THE STOMACH SIMULATING TUMOR*

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DURING the past two years we have been interested in a peculiar shadow in the cardiac end of the stomach. In the course of our observations this impression of a filling defect has revealed itself in different sizes, shapes, and forms, yet fundamentally adhering to some definite characteristics. It confused us in one case and since in two others elsewhere this defect was mistaken for tumor, it will be of some value to roentgenologists to report our observations to aid in preventing future false impressions.

FIG. 1. Case 1. This was our first case which showed a defect in the cardiac end of the stomach closely simulating tumor. The patient had been under observation two years for prepyloric ulcer. At this examination there was an exacerbation of the symptoms.

This shadow first came to our attention in a diagnostic case which was of considerable concern to us. In making our final report we were inclined to call it a tumor mass, which we believed to be malignant. The next day, however, another case presented itself with totally different gastric symptoms and a stomach roentgenologically negative which had the same filling defect, somewhat altered, but nevertheless present and apparent.

The second case following immediately after the first, in addition to a case seen by one of us (Hodges) some time previously, caused us to study this problem. Since then we have seen this peculiar shadow in 47 cases out of approximately 1,500 gastrointestinal examinations. While this is a low incidence, it is common enough to have some significance and bears an important rôle in differential diagnosis. Twenty-one of the 47 signs, if it can be called a sign, were more or less typical star and circle impressions, or a percentage of 1.4 per cent. Twenty-six were variations of this picture.

The impression, while it follows quite closely a certain pattern, seems to differ in many individuals. Since there are many variations, a characteristic name is difficult to offer. We have considered such terms as "crescent and star," "circle and star," "stellate impression," all of which possess some merit.

The finding is best described as a circular protuberance or filling defect which varies in diameter from 1 cm. to 2 or more cm. It occurs exactly at the esophageal-gastric opening. It appears to vary in its depth, width, and thickness, and in most cases presents a stellate-shaped center produced by three to five strands which radiate from a

* Read at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

central point toward a ridge-like periphery.

There are usually one or more complete circles, but in some a half or three-quarter circle may show. The strands, of course, are the result of adherent barium which clings to the esophageal mucosa as it folds or pleats in its resting state. The mound or ridge-like periphery is probably due to slight protrusion of the lower esophageal mucosa. It is this mass-like filling defect which produces a displacement of barium simulating tumor. Mosher has shown that the muscularis mucosae is thickest at the lower end of the esophagus and that there is a folding together of the deep vertical pleats.

There is no elucidative reason why this is seen in some individuals and is entirely absent in others, except that in some individuals the lower esophagus, instead of extending more or less straight down into the stomach, passes from right to left and forward, to enter the stomach in a horizontal plane. The type of barium meal used plays no important part in the production of this phenomenon. It has been encountered with plain barium-water mixtures, with added flavoring material, and with the stomach partially or completely filled.

FIG. 2. Case I. The circle and star at the location of the defect shown in Figure 1 proves this to be due to the lower end of the esophagus and not to tumor.

FIG. 3. Case II. A typical star and circle defect or stellate impression at the esophageal-gastric opening.

Technical factors do have a definite influence. The shadow is best seen in fast Potter-Bucky films. Films made by a slower Potter-Bucky technique or fast films without the aid of grid protection have also demonstrated this sign, but not as well as fast Potter-Bucky films. It has been found in practically all types of individuals with and without digestive disturbances, fat, lean, tall, short, young, old, male and female.

Position seems to be the most important factor. In nearly all of the cases the sign is only seen in one position and this is the right-oblique prone, the position assumed

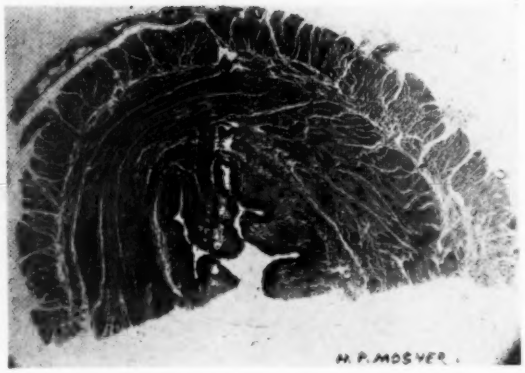

Fig. 4. Cross section of one-half of the lower end of the human adult esophagus showing the normal pleating (from Mosher and McGregor).

to best show the duodenal bulb on the roentgenographic table.

In view of this a definite anatomical alignment of the esophagus and stomach must be obtained for best production of this sign. The excellent work of Mosher explains in part how this phenomenon might be produced. His discussion of the liver tunnel and the change in position of the esophagus from a vertical path to a horizontal direction offers a plausible answer. If the vertical roentgen-ray beam could be projected at all times to enter this horizontal position of the esophagus it seems probable that we would encounter this finding in a majority of our cases.

In patients showing the stellate impression we have tried projecting the roentgen-ray beams above and below the normal position. This altered the appearance somewhat but did not entirely obliterate our finding. The tube, however, was not displaced a great distance, and if it had been there is not much doubt that obliteration would have resulted. Theoretically, it should best show on expiration but this apparently has not been the case.

Although the central ray may be projected in a stationary plane the deformity may be missed on a single film or two. In our routine roentgenographic work we may take from five to twelve films, and of this number frequently only one or two films will show the impression to good advantage and in the remaining only a faint shadow may be observed. Therefore, some intrinsic characteristic phenomenon of the mucosa probably plays some part in its production, suggesting that there may be a peculiar arrangement of the muscle layers or piling up of the mucosa following the act of deglutition.

While there is some disagreement as to whether or not there is an actual sphincter at the esophageal orifice, there is a sphincteric action. This sphincter is controlled by the vagus nerve. During the third stage of deglutition an inhibition of sphincter action takes place causing it to relax. Immediately after swallowing, the esophagus in the lower part goes into a contraction more vigorous than usual and may remain so for a long time.

We have on a number of occasions found a characteristic stellate impression in patients with indefinite digestive disturbances. Re-examination of these same cases

Fig. 5. Case III. A small defect in the cardiac end of the stomach. This simulates tumor but an indistinct circle and star are present.

after they were symptom free has shown not nearly as much spasm of the esophageal orifice and atypical impressions. This has suggested the idea that there may be such a thing as spasm of the cardiac sphincter without dilatation of the esophagus, just as we can have pylorospasm without dilatation of the stomach. It may be that there is a reflex spasm of the so-called cardiac sphincter due to disease elsewhere in the digestive tract.

Since these cases have occurred in nonsurgical patients no anatomical explanation can be offered. None of our cases has come to autopsy. Therefore, our reasoning must be based on conjectures rather than palpatory or visual evidence, except that in some instances barium lines can be seen to follow the esophagus directly into this stellate impression.

The rôle played by adjacent structures such as the liver, the crura of the diaphragm, or the tips of the lungs does not offer conclusive deductions. In the routine survey films of the abdomen preceding a gastrointestinal series, there is no abnormality of the liver shadow. Likewise the position of the diaphragm has offered no answer. It is seen on inspiration and expiration. Disease processes in the gastrointestinal tract or its allied organs have given no hint.

Fig. 6. Case IV. A rather large defect in the cardiac end of the stomach simulating tumor but lines of barium can be seen to enter this defect from the esophagus, which excludes tumor.

Fig. 7. Case V. A carcinoma of the cardiac end of the stomach which simulates the stellate impression. On the fluoroscope barium could be seen to pass around and over this lesion instead of directly into it.

The sign, if we may call it such, has been found in advanced gastric carcinoma as well as in a roentgenoscopically normal stomach. We have found it in duodenal and gastric ulcer cases. It has been found in gallbladder disease with and without stones. There appears to be no connection with the form of the small bowel pattern. We have seen it in diverticulosis of the colon. It occurs in instances of high, normal, and low gastric acidity. Cannon's work on the acid control of the so-called cardiac sphincter

suggests that it would be found most often where there is normal or increased gastric acidity.

We have not seen it in cardiospasm. This again suggests that its production is based on some motor phenomenon relative to the activity of the mucosa or muscular layers. We have not encountered a "curling" of the esophagus in connection with the shadow. Nor have any of the cases presented varices or any demonstrable pathological changes in the esophagus itself.

The typical ones can readily be diagnosed as anatomical alterations but in many instances the defect may closely simulate a tumor. At times it may require a second roentgenoscopic examination and films from various angles to differentiate the two. If it is a tumor the barium will be seen as a rule to pass around the defect instead of into it. In a cascade type of stomach a pocket of air above and to the inside of a very indistinct stellate impression may closely simulate a tumor. We have one such case that was seen elsewhere by an excellent roentgenologist.

CONCLUSIONS

1. A stellate impression in the cardiac end of the stomach is due to the esophageal orifice.

2. The typical star and circle sign can be readily diagnosed.

3. Variations of this sign can and do closely simulate tumor.

4. In tumor, barium can usually be seen to pass around the defect instead of directly into it.

5. Most tumors can be shown from different angles while the stellate impression can rarely be seen in any but the right-oblique prone position.

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DISCUSSION ON PAPERS OF DRS. KIRKLIN, AND HODGES, SNEAD AND BERGER

Dr. E. L. Jenkinson, Chicago. I think Dr. Kirklin has done much this morning to clarify the importance and significance of the meniscus-complex. I think a great many roentgenologists were in a quandary as to the exact identification of the sign. I have been interested in the complex for quite some time and have asked a great many candidates before the Board of Radiology to describe the meniscus sign. Most of the candidates were familiar with the significance of the complex but were in many instances unable to describe it as seen on the fluoroscopic screen or in the roentgenogram.

I think Dr. Kirklin has shown us this morning and also in his scientific exhibit the importance of the sign and the "picture" as seen by the roentgenologist. If you have studied his exhibit and listened to his paper I am sure you now have it indelibly impressed upon your mind.

As Dr. Kirklin has said, the lesion is intragastric, also the ulcerated area is intragastric, and not extragastric. This is the important differential point. Careful fluoroscopic examination is imperative and the lesion should be seen before the stomach is distended with the barium meal. Careful palpation is very essential.

We have identified about four meniscus signs during the last four months. All four patients were operated on and were found to have ulcerated malignancies; I think Dr. Kirklin is to be congratulated on bringing this very important finding to us in such a clear and concise manner.

In regard to the paper by Dr. Hodges and his coworkers, when I was asked to discuss this and looked at the title I felt immediately that I knew little, if anything, about the subject. I read the paper which Dr. Hodges kindly sent me, and looked back through our files, wondering if I could find some of these stellate deformities. I failed to find any.

It is probably fortunate for the patients that we have not found the deformity during the time we have been doing gastrointestinal examinations; fortunate for the patients because we would probably have called it malignant.

I think the finding is corroborated by the anatomical charts. If you observe the exhibit I am sure you will be convinced that the stellate impression is at the lower end of the esophagus, looking at it on end, and extends into the

stomach. In my opinion the fact that the esophagus is traceable down through the deformity is an important observation which differentiates it from a tumor. A tumor displaces the lower end of the esophagus. This is not true in the case of the stellate impression.

I feel this way about their contribution: If I had learned nothing else at this very excellent meeting, I believe their contribution is well worth my time spent in attending the meeting.

Dr. Ross Golden, New York. Dr. Kirklin has done something which ought to be done for all roentgenologic phenomena. He has analyzed the physical basis for the phenomenon which we know as the meniscus sign. It is evident from his analysis that if inflammatory changes about a benign ulcer happen to be just right, the same sign can be produced. However, carcinoma is much more likely to produce the essential conditions than is inflammation.

The important thing in the differential diagnosis, as Dr. Jenkinson pointed out, is the situation of the ulcer, and, depending upon its location, there may be great difficulty at times in determining whether it is intraluminal or extraluminal. When the crater is on or very near the lesser curvature, its relation to the wall is relatively easy to establish, but when the crater is not in profile, when it is around the corner, so to speak, on the posterior wall, it may be quite impossible to tell whether that crater is actually intraluminal or whether it is excavating into the wall and projecting beyond what would be the normal contour of the stomach. Dr. Kirklin's analysis has been enlightening and very much worth while.

It seems to me much better as a general principle to think of roentgen manifestations in terms of the basic physical conditions which cause them; in other words, in terms of the gross pathology which produces them, rather than in terms of a "sign" which is specific for a certain single diagnosis.

Drs. Hodges, Snead and Berger have done us a real service by showing that this shadow at the top of the stomach, which may be confused with a neoplasm, is apparently due to the motor phenomena in the mucous membrane around the cardiac orifice. This is a very nice example of the way refinement of our knowledge of roentgen manifestations in the stomach takes place and it deserves our highest praise and congratulations.

Dr. Eugene Freedman, Cleveland, Ohio. Dr. Kirklin referred to the paper written by Dr. Goehring and myself in which the statement was made that the meniscus sign may occur in both benign and malignant lesions. I realize now that this statement was due to a misconception of Dr. Kirklin's criterion. We felt that the transparent halo due to the overhanging ridge was the main and important factor of the complex and have not paid enough attention to the other, probably more important factor, i.e., to its intraluminary situation. In our case the crater extended into the gastric wall and formed a bas-relief extending considerably higher than the inner wall of the stomach above and below it.

During the June, 1941, meeting of the American Medical Association, I had the opportunity to study Dr. Kirklin's exhibit on the meniscus sign and it was only then that I fully realized the importance of the second factor, the intraluminary situation of the crater.

Since that time I have made the diagnosis of the presence of meniscus sign indicating a small ulcerating carcinoma in 2 instances. Both of these patients came to operation subsequently (one at the Mayo Clinic) and the diagnosis was verified in both instances.

In view of my corrected conception of the meniscus sign, I realize now that our illustration represented only one factor of the sign. The two subsequent instances where the utilization of all the factors allowed me to establish the correct diagnosis seem to confirm Dr. Kirklin's statement that the meniscus-complex represents a valuable pathognomonic index.

DIVERTICULA OF THE DUODENUM

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ACCORDING to Kellogg, priority for describing duodenal diverticula belongs to Chomel, who in 1710 described a case in which the duodenal diverticulum or pouch was secondary to a cholecystoduodenal fistula. The credit has erroneously been given to Morgagni in 1765 and Sommering in 1794. Duodenal diverticula were first recognized roentgenographically in 1912 and the first surgical excision was carried out by Forssell and Key in 1915.

Baldwin says that "generally speaking diverticula of the duodenum are rare in comparison to the number of diverticula described in the literature as occurring elsewhere in the intestine." Diverticula occur in the intestinal tract more frequently in the colon, jejuno-ileum, esophagus, pharynx, but less frequently in the stomach. Grant concludes, after studying numerous bodies in the dissecting room at the University of Toronto, that duodenal diverticula are common after the fifth decade of life, and that they do not become progressively more common with advancing years. Case found that in 6,847 complete barium meal studies, 85 showed characteristic evidences of duodenal diverticula. Spriggs and Marxer, in the last 1,000 consecutive roentgen examinations of the alimentary tract, found 10 cases of duodenal diverticula. Linsmayer found 45 cases in 1,367 autopsies and Rosenthal found 3 in 100 cases. Horton and Mueller, at the Mayo Clinic, found duodenal diverticula in over 5 per cent of 216 autopsies.

There are two types of duodenal diverticula, the congenital and acquired. The acquired can also be divided into true, which, like the congenital, contains all coats of the intestine—the mucosa, submucosa, muscularis, serosa—and false, which really is a hernia of mucosa and submucosa through a rent in the muscularis coat. They may also be classified or described as cylindrical, spherical, sessile, globular, pyriform, funnel shape or finger-like.

According to Lahey "most duodenal diverticula, even though they appear on the outer wall of the duodenum, arise from the posterior aspect, adjacent to that point at which the common bile duct enters the duodenum." Hatchette, in discussing diverticula of the duodenum, says, "that Melville states that acquired diverticula are generally found in the first part of the duodenum as a result of ulceration . . ." and "that congenital diverticula are generally found in the second part of the duodenum, rarely in the third part, and never in the first part." Morton, after a review of the literature, concluded that the majority of duodenal diverticula arise in the region of the ampulla of Vater.

In Grant's series all but one sprang from the concave or pancreatic border and were buried in the pancreas. Usually the seat of hernia was at the point of entrance or emergence of blood vessels, particularly the veins. Bell states that "the relaxation of venous sheaths in association with circulatory stasis (Graser), fatty degeneration of the muscularis (Roth), and fatty infiltration of the intestinal wall (Aschoff), were conspicuous in certain cases and considered as the causes of the diverticula. Atrophy of the pancreas, ptosis of the duodenum, traction upon the duodenal wall, increase in pressure from intestinal contents, liquid or gas, have been advanced as causative factors."

Some writers claim that both sexes are equally affected but Kellogg finds from autopsy studies a greater frequency in males—about 62 per cent. Diverticula of the duodenum have been seen in children but are extremely rare. According to Davis 16 per cent occur below the age of fifty, 37 per cent between the ages of fifty and

sixty and 47 per cent over sixty years (Kellogg[8]). Busche states that 80 per cent occur after the age of fifty (Case[3]).

There is no clinical syndrome characteristic of duodenal diverticula. Symptoms may be entirely lacking and one gathers the impression from a study of the literature that in most instances primary duodenal diverticula do not cause symptoms. However, there are instances where symptoms have been due to the diverticulum since its removal has been followed by complete absence of the symptoms. The symptoms may be those resulting from some inflammation or distention of the sac, from inflammation of surrounding structures, or from pressure exerted by the distended sac upon adjacent tissues and organs. Pain in some form is the most constant symptom. It may be of a dull aching type or a dragging, boring sensation, referred to the right upper quadrant, midline or epigastrium. The onset is usually gradual, occurring from one to four hours after meals. Sometimes the pain is relieved by alkalis and by the taking of food. The symptoms may be those of some vague digestive discomfort, and may follow a gastric or duodenal, a pancreatic or biliary, an intestinal or colonic pattern. It can therefore be seen that there is no clear cut picture by which a clinical diagnosis can be definitely established. The diagnosis is only accurately made by the roentgenologist, the surgeon and the pathologist. However, when a patient, with symptoms referable to the upper abdomen, can be proved to have negative examinations of the gallbladder and biliary tract, of the stomach, pancreas and intestinal tract, then a diverticulum may be suspected.

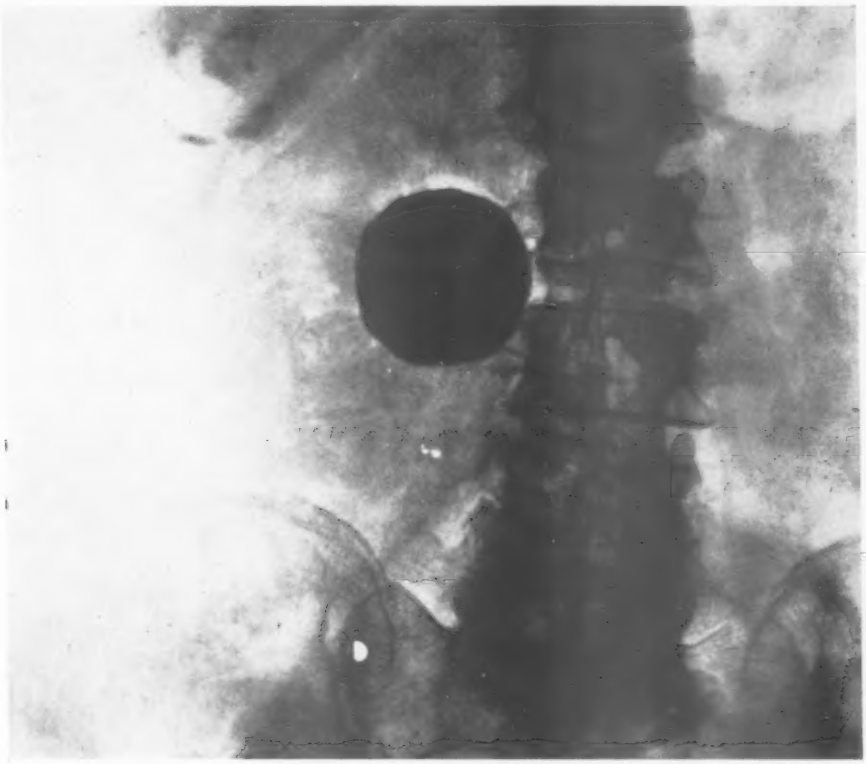

Fig. 1

The treatment is surgery. Morton says "although primary duodenal diverticula are relatively common, indications for surgery upon them have not been of great

frequency. In the University of Rochester Hospitals, primary diverticula of the duodenum have been recognized in at least thirty-three individuals, but operation has been performed in only two instances." At operation or autopsy the diverticula are found to contain mucus and the usual duodenal contents. Up to 1920 there were only 2 cases reported in the literature where gallstones were found in the sac. One case had one stone and one case had twenty-two small stones.

The case I am reporting is unusual for three reasons, first, because of a large, duodenal diverticulum; second, because it contained a gallstone, and third, because the stone was the largest on record, nearly 2 inches in diameter.

REPORT OF CASE

The patient was a woman, aged seventy-seven; weight about 165 pounds. On the night of June 4, 1936, the patient had a very restless night. About 8 A.M. June 5, she was seized with severe pain in the right upper quadrant radiating to the back. This was followed by nausea and vomiting. The vomiting was repeated four times by noon. Her family physician made a diagnosis of acute cholecystitis with stones and gave her a quarter of a grain morphine for the pain. During the afternoon I saw the patient in consultation, agreed with the family physician as to the diagnosis, and sent her to the hospital. Her family history was negative but her personal history revealed several points of interest. At the age of twenty-two she had an attack of jaundice with chills and fever. Also, four years ago she had an attack of pain in the abdomen which was thought to be appendicitis, pyelitis or cholecystitis. The condition cleared up in about ten days under medication. The patient has always enjoyed a good appetite, but has been troubled with gas and belching. On admission, the leukocyte count was 15,000, temperature 101.1° F., pulse 110 and respirations 24. She was extremely tender in the upper right quadrant and there was marked rigidity over this area. The abdominal examination otherwise was negative. A flat plate of the abdomen was reported by the late Dr. W. F. Manges of Jefferson Hospital as follows: "There is a laminated stone in the right upper abdomen that is at least 2 inches in diameter and almost perfectly round. It is probably in the gallbladder." The patient was given conservative treatment, studied more thoroughly and prepared for operation. On June 6 her blood count showed hemoglobin 75 per cent, 3,830,000 red blood cells, 10,500 white blood cells with 89 per cent neutrophiles.

On June 8 the white blood count was 8,200. Her liver function on June 8 showed all dye removed. The indirect van den Bergh test was negative; direct and quantitative van den Bergh test was 0.5 mg. The urine showed a very faint trace of albumin and was negative for other findings. Temperature and pulse slowly became normal and after several days of preoperative preparation her abdomen was opened on June 12, by Dr. Thomas A. Shallow, Professor of Surgery at Jefferson College, assisted by myself, and a small, normal gallbladder was found. The large stone revealed in the roentgenogram was found to be in a diverticulum of the second portion of the duodenum. This stone and diverticulum were removed and the abdomen closed.

The patient made a very satisfactory progress after operation for several days, but after a week her condition became retrogressive. The urinary output gradually decreased and finally the kidneys refused to function in spite of every treatment and on June 25 the patient died of uremia.

CONCLUSIONS

1. Duodenal diverticula are rarely diagnosed before operation or before autopsy.
2. The preoperative diagnosis is usually cholecystitis, either acute or chronic, or some other gastrointestinal condition.
3. Many cases go undiagnosed, since they were never roentgenographed, never operated on, and postmortem examinations were never made.
4. The condition is more common than generally thought.
5. The treatment is surgery.
6. Gallstones in duodenal diverticula are extremely rare.
7. The correct diagnosis, preoperatively, is only made by roentgen examination.

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PLATYBASIA, KLIPPEL-FEIL SYNDROME AND SPRENGEL'S DEFORMITY*

By WILLIAM FURST, M.D., *and* HERMAN W. OSTRUM, M.D.
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THE simultaneous occurrence of three rare developmental anomalies in the same patient prompted the reporting of the following case:

REPORT OF CASE

S. C. (Fig. 1), male, Negro, aged twenty-nine, was admitted to the Neurologic Service of Dr. J. C. Yaskin at the Philadelphia General Hospital on May 29, 1940, following a generalized convulsion. The past medical history was essentially negative with the exception of a deformity of the neck and left shoulder present since birth. For the past six years, he drank excessively and since 1936, suffered from right-sided morning headache lasting several hours, relieved either by fainting or sleeping. Generalized epileptiform convulsions first occurred in 1937 during one of which he fell out of a window suffering multiple contusions but no head trauma. Since then, convulsions recurred about every two weeks. The systemic review was otherwise negative. Examination revealed a well-built and muscled male Negro with marked upward displacement of the left shoulder, short neck and flaring trapezii. There was moderate limitation of movements of the neck in all directions and muscular atrophy of the left shoulder girdle. The remainder of the somatic examination was negative. The significant abnormal neurological findings were: A left central facial weakness, loss of the associated movements of the left arm and increased left but absent right biceps reflex. Laboratory studies were normal. Complete ophthalmological examination was negative. The tentative diagnosis of a predominantly right-sided cerebral lesion, possibly porencephalic cyst, meningioma or a vascular lesion, was made. Shortly after admission, the patient complained of micropsia, became assaultive and was transferred to the Psychopathic Ward where, after a short period of memory impairment, hallucinations and increased psychomotor activity, he admitted to being addicted to marihuana. Recovery was rapid and convulsions failed to recur without any medication. He refused to submit to further study and was therefore discharged. In a follow-up study, six months later, he stated that since abstaining from alcohol and marihuana, he had remained free of convulsions.

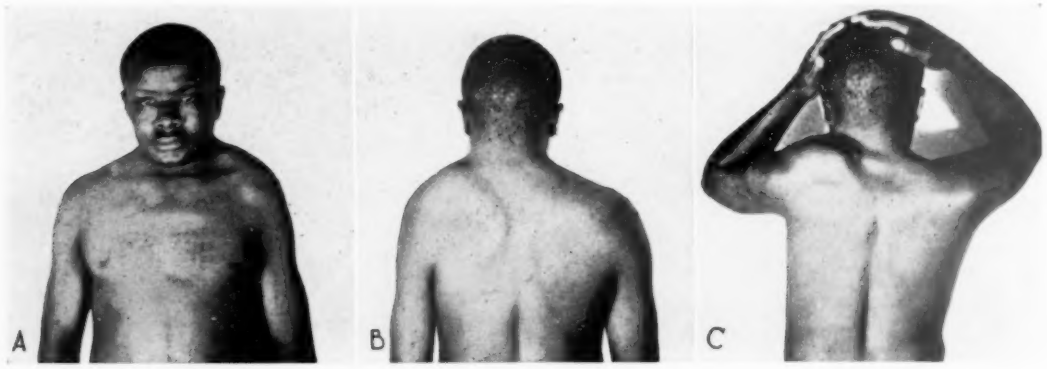

FIG. 1. Note the short neck, atrophy of the left shoulder, limited neck motion and upward displacement of the scapula.

Roentgenograms of the skull, neck and scapula (Figs. 2, 3 and 4) are of particular interest.

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DISCUSSION

To our knowledge, the combined occurrence of platybasia, congenital synostosis of the neck (Klippel-Feil syndrome) and Sprengel's deformity is unreported in the literature. Ebenius,[1] in discussing platybasia, stated that deformity of the axis and fusion of the vertebral bodies of the upper

Fig. 2. The foramen magnum is much flattened and stenosed.

cervical region may occur giving a roentgen appearance which may resemble that present in the Klippel-Feil syndrome. Lichtenstein[2] believed that the latter condition may be a connecting link between an elementary form of the Klippel-Feil syndrome and Sprengel's deformity. In both conditions there may be a high position or incomplete descent of the scapula with absence of vertebrae or anomalies in number. It is probable, therefore, that the anomalies in our case have a common congenital etiological relation. It is also interesting to note that in spite of the advanced degree of bony

Fig. 3. The first cervical vertebra is situated much higher than normal extending into the foramen magnum (platybasia).

Fig. 4. There is fusion of the second and third cervical vertebrae with congenital spina bifida and hemivertebrae in the lower and upper thoracic regions. The left scapula is small and elevated.

malformation, there were few neurological signs demonstrable.

SUMMARY

1. The unusual occurrence of platybasia, synostosis of the neck and Sprengel's deformity in the same patient is reported.

2. A common congenital etiological relation is probable.

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CHORIONEPITHELIOMA IN THE MALE AND FEMALE AS OBSERVED ROENTENOLOGICALLY

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THE aim of this publication is to present a roentgenological description of the various forms in which chorionepithelioma might occur in the roentgenogram, coordination between roentgenological and clinical diagnosis, observation of 2 cases of extragenital chorionepithelioma in the male and discussion of the various problems and aspects which chorionepithelioma in the male presents.

In 1931, I[1] observed and published a case of chorionepithelioma in a man, the extragenital origin of which was definitely established by autopsy. It was at that time the third such case in the literature and was recognized by Kantrowitz[6] as one of the few definite cases in which the necessary criteria for the diagnosis of an extragenital primary chorionepithelioma in a man were fulfilled. From the study of the roentgenogram at that time, I concluded that it might be possible to diagnose such a chorionepithelioma from the roentgenological appearance of its lung metastasis and I had a recent occasion to prove that statement in another case which came under my observation. In June, 1939, a male, aged eighteen, entered our Hospital and came to the Department of Roentgenology under the tentative diagnosis of unresolved pneumonia with empyema in which the roentgenogram alone without any knowledge of the clinical symptoms immediately recalled the previous case and suggested the diagnosis of mediastinal teratoma with chorionepithelioma metastasis in both lungs. Consequently, the Aschheim-Zondek test was done (Friedman modification) and was strongly positive. Clinical examination detected the gynecomastia, and some colostrum was present. There was no enlargement of the testicles; rather some atrophy was present. These findings together might suffice to put the second case in the same class with the first although an autopsy in our second case could not be obtained.

Biologically and oncologically, these tumors are, as MacCallum and Boyd state, of the greatest curiosity and have attracted the attention of our greatest physicians. There are, however, few roentgenological observations, and even the more common chorionepithelioma in the female with its lung metastasis, is roentgenologically little studied and usually first misinterpreted as tuberculosis on account of its bleeding or as pneumonia on account of its rapid development. Pund, Greenblatt and Thompson[11] describe a case of malignant hydatid mole with presentation of many focal nodules over both lung fields and recurrent hemorrhage as the leading symptom. One large single nodule at the base of the right chest, parapleural, was described by Weil[12] in a chorionepithelioma in a woman, while Blum[2] described a more miliary form of metastasis also in a woman. Jüngling[5] reports a case of chorionepithelioma detected in a tuberculosis sanatorium and for some time regarded as tuberculosis. As occasionally even uterine symptoms are absent, pain in the chest, hemoptysis and lung foci in roentgenograms might give the first clue to the detection of the disease, but are easily mistaken for tuberculosis. Such a case is also described by Manz, where clinically the diagnosis of tuberculosis was made, but at autopsy chorionepithelioma metastases were found. The lungs are most frequently and very rapidly involved. Osseous metastasis occurred as well as liver, brain and kidney involvement, but as far as I was able to discover, no roentgenological observations in these locations are published.

While these observations with the exception of Jüngling's case are in females, the chorionepithelioma in males has its origin

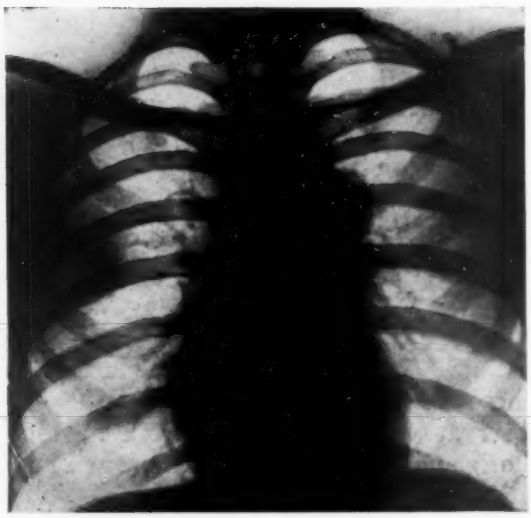

Fig. 1. Case 1. Chorionepithelioma in a male, aged twenty. Misinterpreted as pneumonia. For later development see Figure 2. Extragenital origin in mediastinal teratoma proved by autopsy.

usually in a teratoma of the testis, developing by partial differentiation of pluripotential cells (Boyd) or by separation of a blastomere (MacCallum), capable of forming certain tissue whatever its own situation. The cases previously described as chorionepithelioma of extragenital origin were: 1 case of omentum tumor with liver metastasis, 1 case of involvement of the pineal gland, 3 cases of retroperitoneal chorionepithelioma, 1 case originating in a dermoid cyst, and 1 case in a mediastinal tumor. The ages of the patient varied between four and sixty-nine years, with the average about twenty. Sometimes the chorionepithelioma may grow so rapidly that it outgrows all other teratomatous tissues and only chorionepithelioma is found. On the other hand, spontaneous regression and complete cure are observed even after lung foci have appeared.

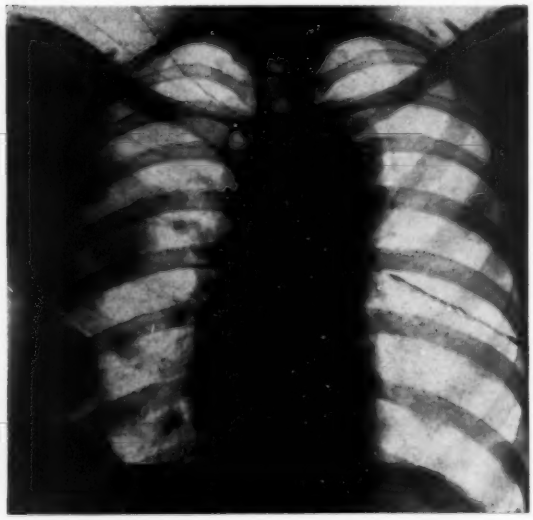

Fig. 2. Case 1. Showing multiple nodular metastasis and large mediastinal tumor above the left hilum.

Fig. 3. Case 11. Chorionepithelioma in a male. Large nodular form of lung metastasis. Mediastinal tumor apparent above hilum bulging into lung fields.

Case 1. Our first case was a male, aged twenty. He showed early signs of gigantism and genital underdevelopment. He also told his mother that his breasts showed some secretion. Because of his overgrowth, the family doctor gave him some injections of testicular extract. He improved greatly and became engaged to marry, but soon showed some signs of deep psychic disturbance. He became alienated from his family. He appeared in criminal circles and made an attempt at suicide. Two months before admission, he became ill with dyspnea, some elevation of temperature and bloody sputum. A roentgenogram taken at that time (Fig. 1) showed a broad, irregular peripheral

infiltration in the right upper lobe and was diagnosed outside of our department as pneumonia. When we saw him, he had a female type breast, female hair growth and a definite colostrum secretion. He was dyspneic and very pale and apathetic. Our roentgenogram showed at that time (Fig. 2) numerous large sarcoma-like nodules over both lungs, mostly at the periphery and parapleural. The nodules appeared well defined but were surrounded and embedded in infiltrative processes. Along the lateral thoracic wall, we saw the density of a pleuritic involvement which proved to be a hemorrhagic pleurisy. From the upper mediastinum, a large oval shaped, well defined tumor mass was bulging into the left lung field with some displacement of the trachea and the main bronchus towards the right side. On the lateral view, the tumor was located in the anterior upper mediastinum and was of a homogeneous density. The patient received some deep roentgen therapy, but he died before the treatment could be effective. At autopsy, a teratoma the size of a fist was found in the anterior mediastinum with perforation into the left lung and into the pericardium. Numerous metastases were found in the lungs and in the liver. The testicles were atrophic and showed marked proliferation of Leydig cells with atrophy of the tubular elements. Microscopically, the lung metastasis showed the typical trophoblastic appearance of chorionepithelioma.

Case II. Our second case again was a young man, aged eighteen. Four weeks before admission, he became ill with cough and expectoration, pain in the chest and fever. Influenza

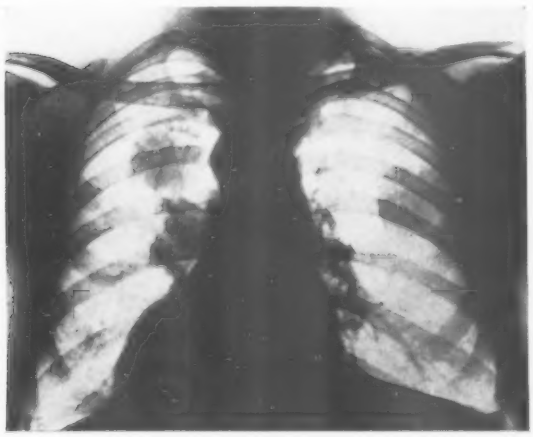

Fig. 4. Typical picture of metastatic bone sarcoma for comparison with Figures 1 and 3.

Fig. 5. Case 1. Lungs at autopsy. Mediastinal teratoma with multiple nodular chorionepithelioma metastasis.

was diagnosed and the patient began to recover, but suddenly he developed profuse blood expectoration, chills, anemia and weakness. Admitted to our Hospital on June 4, 1939, he had on physical examination moist and sibilant râles over both bases and numerous crepitant râles in the right axillary space. The testicles were atrophic. Gynecomastia of moderate degree and colostrum secretion were found. The roentgenogram (Fig. 3) taken at that time showed numerous tumor nodules within both lung fields varying in size from that of a cherry to that of a tangerine (cannon ball appearance). There was a pleural effusion at the right base. Some of these tumor nodules upon close examination were not so well defined, but, as on our film, embedded in infiltrations. There was the same type of mediastinal tumor visualized as in the first case and the similarity of both pictures was striking. The patient became comatose and died on June 14, 1939.

COMMENT

We have before us 2 cases of chorionepithelioma of extragenital origin and nature in the male, both diagnosed during life by

Fig. 6. Roentgenogram shows the hemorrhagic areas surrounding the tumor nodule causing a blurring of the outlines and blending with the surrounding tissue.

the roentgen appearance of the lung metastasis and verified in the first case by autopsy, in the second case by the Aschheim-Zondek reaction, gynecomastia and clinical course.

The roentgenograms showed nodules which were round, well defined, and of concentric growth; they resemble most closely sarcomatous metastasis,—but upon close examination of the edge, we see here and there a blending of the otherwise sharp outlines with the surrounding tissue, and often the nodule is embedded in a lobular infiltration and therefore might be mistaken, as in our first case, for pneumonia. This phenomenon of softness and blurring of the edge of an otherwise well defined nodule might well be of importance in the differential diagnosis. The chorionepithelioma in the male as well as in the female has the tendency to open up blood spaces and to perfuse by hemorrhage an area of the surrounding tissue which is actually not yet invaded. That is what we see in the roentgenograms. In both cases, these nodules were present, together with a mediastinal mass and some hemorrhagic pleurisy. The chorionepithelioma with its tendency to cause hemorrhages is here also more evident than in seminoma and sarcometastasis. We must at least consider the diagnosis of chorionepithelioma if a lung picture such as this is combined with a mediastinal tumor or a large testicle in a male and a pathological pregnancy or abortion in a female.

Once suspected, the Aschheim-Zondek reaction confirms or disproves the diagnosis. The Aschheim-Zondek test in the second case was strongly positive which in the adult male narrows the diagnosis to a small group. The prolan B reaction is almost pathognomonic of chorionepithelioma. Heidrich, Fels and Mathias[4] found that in a case of chorionepithelioma in a male three months before death 0.5 cc. was sufficient to cause a positive luteinization reaction as the tumor grew, and these authors calculate that in a liter of urine about 35,000 mouse units of anterior pituitary hormone 250 mouse units of female sexual hormone were present as compared with 10,000 mouse units in the gravid female organism.* Such a high hormone output confirms the diagnosis once it is suspected, even if the tumor is too small to be detected. A seminoma of the testes does not give prolan B reaction which is of differential diagnostic importance.

The prolan reaction, however, is not sufficient proof of a chorionepithelioma as it is found also in seminoma, in teratoma, and in embryonal cancer. When the quantitative test is done, the Aschheim-Zondek test is important not only as a confirmation of the diagnosis, but also as an indicator of the extent and progress of the disease and of the effect of radiation therapy. Chorionepithelioma gives the highest excretion, seminoma the least, 500–1,500 mouse units, and embryonal carcinoma a medium amount, between 2,000 and 10,000 mouse units. An-

* Up to 200,000, even 1,000,000 mouse units found in chorionepithelioma.

other point of differentiation is, according to Keyes and Ferguson, the form of spread. In seminoma, there is usually a lymphatic spread with glandular involvement; in embryonal cancer, lymphatics *and* veins are involved; in chorionepithelioma an almost exclusively venous distribution is present.

The other clinical symptoms, feminization and gynecomastia, while present in our cases, are also found in adrenal cortex tumor, in pituitary tumor, and in tumor of the testicles. In extragenital chorionepithelioma, it is reported in the case of Schultze. Such changes are, in our opinion, the direct sequence of the secretion of large amounts of the prolans. While the gonads of all embryos are identical, always testicular according to Wolff, in later development there is an antagonism between male and female gonads. Pezard and Caridroit observed the development of secondary female sex characteristics in cocks by implanting ovaries into them, and Steinach brought male and female rats in parabiosis by operation and observed regressive changes in the testicles and the development of female sex characteristics. The appearance of gynecomastia after injury of the testicle is described by Lacassagne and this is not astonishing as chorionepithelioma of the testicles often follows injury. Two more such cases were recently reported by Knoflicek.[8] We are convinced that more cases of chorionepithelioma in the male will be observed if the Aschheim-Zondek test and roentgen study are made in each case of a testicular tumor.

We mentioned above several other forms in which chorionepithelioma might be encountered on the roentgenogram: the miliary form as described by Blum, the foci being somewhat larger, but otherwise like miliary tuberculosis; another form simulating pneumonia; and most frequently, the large nodular type with blurred outlines and hemorrhagic pleurisy. Such cases are described by Weil and recently by Pund *et al.*

Of greatest interest are biological and oncological questions which these tumors arouse, questions of aberration and metaplasia, absence of a growth inhibiting hormone, the question of the identity of chorionepithelioma in both sexes, of tumor descendency and consanguinity, of the causes of spontaneous remissions; but we have limited this discussion to the roentgenological and diagnostic aspects of the problem.

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HODGKIN'S DISEASE

FIVE YEAR SURVIVAL RATE; VALUE OF EARLY SURGICAL TREATMENT; NOTES ON FOUR CASES OF LONG DURATION

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MATERIAL ANALYZED

FROM 1918 through 1935 there have been 265 cases of Hodgkin's disease treated at the Memorial Hospital, all proved by biopsy and histological examination. This group of cases has been almost entirely under the care of one of us (L. F. C.) during this interval, and all the histological diagnoses have been made either by Dr. James Ewing or Dr. F. W. Stewart. This series represents an almost irreducible minimum of proved cases, as all doubtful cases in our files have been reviewed recently by Dr. Stewart and discarded if they were not clear cut on microscopic examination. These cases, therefore, constitute a fairly homogeneous series from the standpoints of observation and diagnosis. Of this group of patients, 26 are still living at present, 28 have been lost to followup and are considered dead, and the others are all dead of their disease, except one who died from another cause.

AGREEMENT WITH OTHER SERIES

Statistical analysis of this group shows a general broad agreement with published reviews of other large series. Goldman has recently studied 212 cases of Hodgkin's disease proved by biopsy in which he found the average length of life from onset of symptoms to be thirty-two months, and the survival following therapy to be 23.8 months. Most of his cases occurred in the third decade of life and the sex distribution was males, 67.5 per cent and females 32.5 per cent. He could find no correlation between the histopathological picture and course of the disease, nor could he add anything to the etiology of this condition. The five year survival rate in his series following treatment was 10 per cent.

LACK OF CORRELATION BETWEEN SEX AND PROGNOSIS

Epstein has emphasized that the disease is not only less frequent in females, but is also much less severe. He analyzed a large series of cases gathered from the literature from many sources and concluded that one-half or more women with Hodgkin's disease survive more than five years and that one-fifth survive ten years. Our figures do not approach these results. Of our forty-seven five year survivors, 21 were female and 26 male.

SURVIVAL AFTER ONSET VS. SURVIVAL AFTER BEGINNING OF TREATMENT

In evaluating the average survival period in Hodgkin's disease, there are several factors which make it difficult to avoid forming an artificial picture of the condition. If we use the time of onset of the symptoms from the patient's history, many inaccuracies are inevitable, and if we use the date of the first treatment we obtain definite time limits but a false conception of the actual course of the disease. This is illustrated by a comparison of the percentages of those dying in less than a year and those living more than five, when calculated both from the onset of symptoms and from the start of therapy. This is given in Table 1.

TABLE I

Survival Periods	From Onset of Symptoms	From Onset of Therapy
	per cent	per cent
0–6 mo.	2.7	17.3
6–12 mo.	8.5	15.1
Over 5 yr.	29.4	17.7

For the reasons given above, none of these figures represents the actual course of the disease, but the second column gives an accurate percentage within its defined time limits. Comparison of the two columns does show that a high percentage of the patients coming to Memorial Hospital with Hodgkin's disease present advanced disease. This is indicated by the difference in survivals less than one year when calculated from the onset of symptoms and when taken from the start of treatment.

In the deceased patients the average survival time after the first treatment is 24.6 months. The average survival of all patients in this series, including living and those lost to follow-up, when calculated from the onset of therapy is 33.8 months. In the latter figure, the 24 cases lost to follow-up have been averaged in only for the duration of their clinical record at this Hospital and if their total course were known it would increase this figure.

TABLE II

	Cases	Per cent	
0– 6 mo.	46	17.3	
6–12 mo.	40	15.1	
1– 2 yr.	55	20.7	
2– 3 yr.	34	12.8	
3– 4 yr.	23	8.8	
4– 5 yr.	20	7.6	
Over 5 yr.	47	17.7	
Over 10 yr.	9	3.4	(Included in five year figures)

Table II shows the yearly survival from onset of therapy.

SEX AND AGE INCIDENCE

In our series of 265 cases, males predominated, constituting 62 per cent, and females 38 per cent. The average age of the patients when admitted to Memorial Hospital was 35.4 years for men and 34.7 for women. The extremes of age were in a male aged five and a male aged seventy-six. Of 12 patients under fifteen years of age, 3 were girls.

SITES OF APPARENT ORIGIN

The great majority of patients with Hodgkin's disease have a painless enlargement of lymph nodes in one region as their initial symptom. Several authors have stressed the fact that the most common site of initial involvement is the left side of the neck and this seems to be true in nearly all series. Some authors, including one of us (L.F.C.), have even gone so far as to predicate a theory of the site of origin of many cases of Hodgkin's disease on this fact, believing that in cases in which the first enlarged nodes appear at the base of the left side of the neck, the disease may have started internally, have been carried through the thoracic duct, and thus have appeared first on the left side of the neck. This is, of course, pure speculation. Table III gives a list of the apparent primary sites of node involvement in our series as noted by the patients as their first symptom.

TABLE III

	Cases	Per cent
Left neck	99	37.5
Right neck	55	20.8
Both sides of neck	19	6.8
Mediastinum	18	6.7
Right axilla	17	6.5
Left axilla	14	
Left groin	10	
Right groin	9	

The other sites in which the disease was first discovered are divided among the spleen, abdomen, nose, nasopharynx, neck and axilla, abdomen and axilla, lumbar spine, right humerus, sternum and skin.

LACK OF CORRELATION BETWEEN HISTOPATHOLOGY AND CLINICAL COURSE

Numerous attempts have been made to correlate the course of Hodgkin's disease with the histopathological picture of the tissue removed for biopsy. Practically

everyone has given it up as an impossibility and our series of cases affords no exception. However, in certain instances there may be a clue as to the reason, because biopsies taken at different times in different involved node areas may show totally differing histopathology, though still being consistent with the diagnosis of Hodgkin's disease. It would be interesting to take multiple biopsies on a group of cases, both simultaneously from different regions, and serially

3. "Hodgkin's sarcoma," of which the majority are dead within one year and none are alive over three years.

Our material simply does not admit any kind of correlation. In our 265 cases, 14 have been diagnosed as Hodgkin's sarcoma. Of these, 7 died within one year of the onset of treatment, but the others survived respectively thirteen months, twenty-five months, fifty months, five years, six years, six years, and seven years, six months. Thus

TABLE IV

SUMMARY OF CASES

Total number of cases		265	
Indeterminate group:			
Dead of other causes and without recurrence	0		
Lost track of without recurrence	0		
Determinate group:			
Total number minus those of indeterminate group		265	
Failures:			
Dead as a result of Hodgkin's disease		211	
Lost track of with disease (probably dead)		28	
Living with recurrence		20	
Total 5 year survivors:		47	17.7%
Dead of Hodgkin's disease	21		
Living at present	26		
Of these: 12 have active disease now			
6 have been free for 18 months to 3 years			
6 have been free for 5 years or more			
2 are now in the terminal stages			
Successful results:			
Free from disease after five years or more (since last treatment)		6	2.3%

during the course of the disease. H. Jackson, Jr., has published a classification of Hodgkin's disease in which he describes three types, each of which has a course and histopathological picture of its own. He divides them as follows:

1. "Early Hodgkin's," with an average duration of 2.6 years, a five year survival rate of nearly 30 per cent and a ten year survival of nearly 20 per cent.
2. "Classical Hodgkin's," with an average duration of 2.5 years, but with 68 per cent dead in less than three years, and a ten year survival of zero.

5 of 14 patients with Hodgkin's sarcoma have survived over three years. Likewise, in the cases with the shortest survival, under six months, there is no consistency in the histopathological picture of the tissues removed for biopsy.

As to the 26 living five year patients, their status at present is as follows: 12 have active disease or have had recently; 6 have had no evidence of disease for periods from eighteen months to three years; 6 patients have been free of disease for five years; 2 patients are now in the terminal stage and will soon be dead of Hodgkin's disease.

PALLIATIVE IRRADIATION FOR CASES WITH DISEASE IN MORE THAN ONE SITE

The prognosis of Hodgkin's disease has been considered hopeless for so long that most workers in this field have contented themselves with attempts at palliative treatment only. Radiation is the principal therapeutic agent used for these cases, and at Memorial Hospital the average routine in the ordinary case presenting disease in several lymph node groups is to use palliative irradiation in amounts sufficient to control the symptoms and produce a remission. In general we use 200 or 250 kv. machines with 0.5 to 1.5 mm. Cu filter, and treat with rather large rectangular portals, giving 200 to 400 r at a time, up to 600, 800, or 1,200 r for a course. This is usually enough to control the local disease and does not cause too much discomfort to the patient. However, it does not insure against local recurrence. Recurrent solitary nodes are usually treated with small circular portals and rather high dosage. We do not believe in prophylactic irradiation, and in general we treat only where there is active, demonstrable disease. Some patients with fever, weight loss, and other evidences of systemic disease but without palpable nodes, are treated over the mediastinal and abdominal fields whether or not there is evidence of lymph node enlargement in these regions. Blood transfusions and other supportive measures are of course used liberally to tide a patient over a threatening episode. It is remarkable how much can be done by carefully selected treatment for some gravely ill patients.

"OBLITERATIVE" IRRADIATION IN CASES WITH LOCALIZED HODGKIN'S DISEASE

The treatment outlined above is for the average case, which is usually one with enlargement of multiple lymph node groups, that is, both sides of the neck, or neck and mediastinum, or other combinations. One of us (L. F. C.) observed that the best results obtained in this series of cases were in those patients who presented only one accessible lymph node group involved, and who received heavy irradiation in fairly large single doses. This might be thought of as "obliterative" therapy as contrasted with palliative. This point of view is in accord with the opinions expressed by Finzi in a paper read before the Fifth International Congress of Radiology in 1937. He said that his longest survivals were in patients with strictly localized disease who received heavy irradiation in fairly large single doses, in two or three courses repeated even after the nodes had regressed. He treated the more extensive cases with multiple small doses. He made the statement that Hodgkin's disease is localized in the beginning and that it is curable in that stage. He made reference to patients of his that have lived as long as eighteen years without evidence of active disease.

Gilbert of Geneva has also expressed the opinion that his best results have been obtained in patients with Hodgkin's disease confined to the cervical region and treated by heavy irradiation, the dosage being much higher than that required for subsidence of the lymph node masses.

SURGERY IN EARLY HODGKIN'S DISEASE

Practically all authors speak only of survival periods in Hodgkin's disease and not of cure rates. In January, 1940, however, Baker and Mann of England published a report of 2 apparent cures of well substantiated cases, one of ten years' and the other of twelve years' duration. These 2 patients had localized disease in one side of the neck and each was treated by surgical excision of all the involved tissue, followed by roentgen irradiation. They remained alive and free from recurrence up to the date of the authors' report. These are the only instances of purported cure in the recent literature, and are of particular interest because they were treated primarily by surgical excision. The fact of cure in these 2 instances is questionable, because in our series there are 3 patients who have had intervals of ten, eleven and sixteen years respectively, com-

pletely free of symptoms or objective evidence of Hodgkin's disease. One subsequently died of Hodgkin's disease, a second died of actinomycosis but was found to have Hodgkin's disease at autopsy, and a third has active disease now after sixteen years. These 3 cases are reviewed in detail at the end of this paper.

Surgery has been considered useless in the treatment of Hodgkin's disease for a great many years, but this report from Baker and Mann prompted a survey of our material from this standpoint. One other recent reference to surgical therapy was found in a report by Gilbert and Sluys of Belgium who quote no cases, but state that surgery is a useful adjunct to radiation therapy in this disease. In our files we found records of 5 patients who were treated by surgery in the sense of a curative attempt. Four had localized involvement in one side of the neck and were treated by neck dissection followed by rather light irradiation to this area. One died of actinomycosis after eleven years, and at autopsy a small pea-sized node in the neck was all that remained as a focus of Hodgkin's disease. A second patient has remained free of any symptoms or evidence of Hodgkin's disease for eight years. A third patient remained well for four years and then developed generalized Hodgkin's disease and succumbed after a year. The fourth patient has remained alive and well to date with no evidence of recurrence after eleven years. Although this case was originally diagnosed as Hodgkin's disease, Dr. F. W. Stewart has reviewed the slides recently and now states that it is unquestionably a malignant and lethal disease, but that he cannot differentiate between a lymphomatous type of Hodgkin's process and an early lymphosarcoma. In either event it is an important case. The fifth surgically treated case presented disease localized to the left groin for which a radical groin dissection was done, followed by roentgen therapy. This patient remained well five years and then developed mediastinal infiltration and died one year later.

Examination of these 7 cases, 5 from our series and 2 from Baker and Mann, reveals that each was an example of Hodgkin's disease localized to one lymph node bearing region. Each of the cases had only the presence of these enlarged nodes as evidence of any disease. There were no systemic symptoms of fever, weight loss, pruritus, etc. The shortest survival period in any of these cases following treatment was five years, the survival periods in our 5 cases being as follows: five, six, eight, eleven and eleven years. Surgical excision was done in 4 of these cases because of a mistaken diagnosis, and in the fifth because irradiation failed to cause regression of a solitary lymph node mass previously diagnosed by biopsy.

We believe that these cases are important because if Hodgkin's disease starts as a localized process it could be cured if it could be stopped before generalization takes place. If it is a systemic condition to begin with, then surgical therapy would of course be without avail. We take no dogmatic position as to whether Hodgkin's disease is an infectious process or a neoplasm, but think of it as analogous to the virus tumors of other animals. The site of lymph node involvement, then, would correspond to the drainage area of the point of absorption of the infective agent. The good results in these surgically treated cases suggest that Hodgkin's disease may not be a systemic disease from the beginning. The results are certainly better than the average course in Hodgkin's disease, but the cases are too few to support any definite conclusions. The postoperative irradiation in these cases was not more than the usual palliative dose, and it therefore may be argued that the surgical extirpation was the decisive factor. Nevertheless, we believe that postoperative irradiation is likely to have contributed to the result, considering the radiosensitivity of early Hodgkin's disease.

Surgical treatment of Hodgkin's disease has been in the discard for so long for several reasons. It is probable that the first unsuccessful attempts were on unsuitable cases, and the surgery itself was probably

inadequate. Second, the medical profession has regarded irradiation as more conservative treatment in general than surgery, and therefore the only therapy justifiable in a disease that has been considered so uniformly hopeless. This latter belief is of course true when light dosages are used and only palliation is attempted. It is not always and necessarily true, however, when really intensive irradiation is given through a large portal. If obliteration of the diseased tissue is effected by such irradiation and the patient lives many years, the late result may in some cases be far worse than from a clearly healed surgical operation. We would recommend, therefore, surgical removal of early accessible Hodgkin's disease when it is strictly limited to one group of lymph nodes, followed by moderately heavy postoperative irradiation, kept within safe limits with respect to the skin tolerance of the individual.

There are in the literature (Avent, Comando, Singer) 9 cases of gastric Hodgkin's disease treated by partial gastrectomy, which should be considered in a discussion of the surgical therapy of this condition. In all of these cases, no other focus of disease could be found. Of these 9 cases, 5 remained free of disease until they were lost to follow-up, but the period of time was too short to be significant. Two of the patients died during the postoperative period and at autopsy no other evidence of disease was found after careful search. One of the patients remained well for four years, but has not been seen since then. The last patient was well for five years after gastric resection, but no further follow-up has been reported so far. One other case reported by Biebl and reviewed by Singer was that of a patient with Hodgkin's disease of the ileum for which resection was done. This patient remained well five years and then had a recurrence in the small intestine, for which another resection was done. The patient was well at the time the case was reported, shortly after the second operation.

These cases of Hodgkin's disease confined to the stomach may be analogous to the gastric type of lymphosarcoma, and as such would constitute a different problem from that presented by the usual patient with lymphadenopathy. They are, nevertheless, Hodgkin's disease, and represent a localized manifestation for which surgical therapy gave better than average results.

DISCUSSION

A study of these 265 cases has enabled us to regard certain cases of Hodgkin's disease in a slightly more optimistic light than heretofore. We believe that it does point to a certain type of case as being more favorable than others. This has little to do with the histopathological picture of the disease, but depends, rather, on anatomical location and extent. Such a case would be defined as one with only one accessible node group involved, no deep adenopathy, and no systemic symptoms as evidence of hidden disease. Such a case if treated by irradiation alone would be best treated with "obliterative" irradiation rather than light palliative doses. We believe that surgical extirpation would be justified in such a case, and should be tried in the future (followed by irradiation within the limits of skin tolerance), at least until enough cases are available for a revaluation of the rôle of surgery in Hodgkin's disease.

Four case histories are presented in detail. These are the 4 cases with the longest course of the disease in our series. They are presented here simply from the standpoint of interest and not as illustrating any particular method of treatment.

REPORT OF CASES

Case 1. This case is one of twenty years' total duration with mediastinal involvement. Following her first course of treatment she had an interval free of disease for sixteen years. She is alive at present but has active mediastinal Hodgkin's disease now.

C. S., white, female, aged thirty-five, born in Russia, occupation housewife. On admission to Memorial Hospital, on March 4, 1921, patient complained of a "neuralgic pain" in right arm and shoulder of three months' duration. One month previous to admission, several lumps the

size of a pigeon's egg had appeared in the left supraclavicular region.

On March 16, 1921, two lymph nodes were excised from the left neck and the histopathological diagnosis was "Hodgkin's granuloma with much fibrosis." A roentgenogram of the chest revealed a widening of the upper mediastinum. Patient was given roentgen therapy to both sides of the neck, both axillae, and both groins. The upper mediastinum was treated by a radon pack, 30,000 millicurie-hours total, administered through anterior and posterior portals at 10 cm. distance. A roentgenogram of the chest taken six months later revealed a marked diminution in the size of the mediastinal mass. A roentgenogram three months later gave evidence of further decrease in size, and one year later the chest appeared normal on roentgen examination. In the meantime the patient had felt quite well and there had been no evidence of disease on physical examination.

In July, 1922, patient became dyspneic and developed a cough with slight hemoptysis on several occasions. Physical examination and chest roentgenograms were negative. Patient was hospitalized and her condition cleared spontaneously, as there is no record of any treatment.

For the next five years she was perfectly well, and physical examination at regular intervals revealed no evidence of disease. In October, 1927, some swelling of the supraclavicular nodes appeared, but this subsided without treatment. In 1928 she was examined by the gynecologic service and a diagnosis was made of multiple myoma of the uterus. She had no evidence of recurrent Hodgkin's disease. She continued well and in January, 1930, underwent a supracervical hysterectomy without complications.

Patient was lost to follow-up until November, 1933, when re-examination revealed a small node, less than 1 cm. in diameter, in the left supraclavicular space. Moderate telangiectasis of the skin over the anterior and posterior mediastinum was observed. No treatment was given. She was re-examined at very irregular intervals and was found to be in good general health until April, 1938.

At this time she was readmitted to the hospital with a history of having had a severe "chest cold" or "pneumonia" two months before. She became dyspneic on exertion, and five weeks before entrance to the hospital a mass developed in the right side of the neck. There had been excessive sweating and some pruritus, but no weight loss. Chest roentgenogram revealed marked widening of the upper right mediastinum. Patient received the following treatment:

Right chest anterior oblique	400 r
Left chest anterior oblique	400 r
Right chest posterior oblique	400 r
Left chest posterior oblique	400 r
Mediastinum direct	200 r
Right neck anterior	900 r

(All treatments with 200 kv. machine, 0.5 mm. Cu, and 70 cm. target-skin distance.)

There was reduction in size of neck and mediastinal masses, but not complete disappearance. Patient was much improved symptomatically, and was able to do her own housework after discharge.

Roentgenograms in following months revealed a persistent upper mediastinal mass, and in November, 1938, patient was given 3×200 r to each of four portals, two anterior oblique and two posterior oblique. These were situated well to the side of the areas of old irradiation dermatitis. Following this there was little diminution in size but about a 50 per cent decrease in density of the mass.

The mass changed very little and patient was asymptomatic for nine months. In August, 1939, a node 2 cm. in diameter appeared in the right neck and a single treatment of 400 r was given to this area.

In December, 1939, patient was readmitted to Memorial Hospital with complaint of severe right chest pain and difficulty in breathing. She was running a fever up to 101° F. (38.3° C.). A chest roentgenogram showed a mass in the right upper lung field. Another series of treatments was given to the oblique portals, 3×200 r to each. On January 24, 1940, a film showed a marked decrease in the size of the mass, and patient was physically improved, with much less dyspnea. In February the cycle of treatments was repeated with same dosage, factors and portals. A film taken the first of March, 1940, showed further moderate diminution in size of the mass. The temperature had become normal. On discharge there was no palpable lymphadenopathy and spleen was not felt.

Since her discharge five months ago, patient has been in fair health, but chest roentgenograms have indicated a gradual increase in the

width of the upper mediastinum. When last heard from, January 20, 1941, she was still doing her own housework.*

Case II. This case may doubtfully be one of thirty-three years' total duration in a patient who had an interval of ten years free of disease, but who subsequently died of generalized Hodgkin's disease. This patient had multiple involvement of the central nervous system. Hodgkin's disease is known to have been present in this patient for only fourteen years, but he had some disease of the lymphatic system for a total of thirty-three years.

D. N. H., white, male, aged thirty, single, occupation, motion picture actor; admitted, February 9, 1937.

In 1906, when he was nine and one-half years old, he underwent a left partial neck dissection by Colonel Fullerton, F.R.C.S., in Belfast, Ireland. Three large masses were removed from the left submaxillary region and numerous smaller ones from the size of a pea to an almond from under the sternomastoid muscle. The diagnosis was lymphadenoma and definitely not tuberculosis. Two years later his tonsils and adenoids were removed and also several recurrent nodes the size of marbles at the upper end of the old incision.

In 1917, while a pilot with the R.A.F., the patient had an aeroplane accident in Aboukir, Egypt, suffering a compression fracture of the third lumbar vertebra and a fracture of the right ankle. Recovery was good.

In 1919 he developed a mass in the left lower neck, which was excised at Salisbury Plain in England. This was sectioned and diagnosed as lymphosarcoma. A course of deep roentgen therapy was given.

In June, 1925, a swelling the size of a hen's egg appeared above the left clavicle. This was excised at the Steiner Clinic in Atlanta, Georgia. At that time nodes the size of peas were noted in the axilla, and soft nodes in the deep cervical chain on the left. Histopathological diagnosis was lymphosarcoma, and roentgen therapy was administered. Regression of the nodes was apparently complete and the patient left the clinic in good condition.

In January, 1927, the nodes recurred in the left neck and the patient was seen at Memorial Hospital. On the basis of his previous history high voltage roentgen therapy was directed to the left neck, anteriorly, laterally and posteriorly, and to both axillae. There were numerous soft movable nodes in these regions. The groins were free, chest roentgenograms negative and spleen not palpable. Regression was good and the patient left Memorial Hospital in good condition. He travelled extensively in the next ten years and was lost to follow-up.

Patient was seen again in New York City in September, 1937, at the New York Orthopedic Dispensary and Hospital. He had been entirely free of trouble for ten years, but at this time complained of severe pain and weakness in the right leg, of nine weeks' duration. Positive findings were as follows: roentgen evidence of deformity of third lumbar vertebra; atrophy of right glutei, hamstring, quadriceps, peroneal group, and calf muscles; decreased ankle and knee jerks; normal manometric readings on spinal puncture but a high total protein in the spinal fluid. On the basis of these findings a laminectomy was done, in spite of the known history of lymphosarcoma. At operation the body of the third lumbar vertebra was found to project slightly into the spinal canal. However, a tumor was found lying on the dura, extending from the upper border of the fourth lumbar vertebra, to about the center of the fifth. It was somewhat irregular in thickness, averaging about 6 mm., and surrounded the dura posteriorly and on each side, but did not extend to the ventral surface. The tumor was vascular, friable, and grayish in color. It separated easily, and there was no evidence of invasion of the vertebra. Apparently the tumor was removed completely, and there was no defect left in the dura at this level. A spinal fusion was done and cast applied.

After the immediate convalescence the patient was referred to Memorial Hospital for roentgen therapy. Just prior to this, slides were procured of the node removed at the Steiner Clinic in Atlanta in 1925. Dr. F. W. Stewart diagnosed them as Hodgkin's disease rather than lymphosarcoma. When patient was transferred to Memorial Hospital, slides of the dural tumor were examined by Dr. F. W. Stewart and this lesion was also diagnosed as Hodgkin's disease. The patient remained at Memorial Hospital from November 7, 1937, until December 30, 1937, and during this time received 3,000 r to two posterior lumbar portals, upper and lower.

* May 20, 1941. Patient was recently readmitted for another course of roentgen treatments to the right mediastinal mass. About two months previously she had had another bout of "pneumonia." The mass is again showing partial regression.

On discharge there was no new evidence of disease elsewhere in the body, and the patient's pain was entirely relieved. He was walking with a cane and wearing both a leg and spine brace.

In a short time the patient returned to Ireland and the rest of his story has been sent to us in a detailed letter from Dr. Jan Fraser of Belfast.

From May until September, 1938, he was well and then developed a sudden Bell's palsy on the left, which cleared spontaneously. In November, 1938, he developed a bilateral fifth nerve paralysis, both sensory and motor, and a severe, constant head pain. He was referred to the Richmond Hospital in Dublin, Ireland, where Professor McConnell and Dr. Parker made a diagnosis of Hodgkin's disease involving the anterior surface of the body of the pons. Roentgen therapy effected a complete recovery.

In May, 1939, enlarged nodes appeared in the left groin, but subsided with irradiation. In August, nodes appeared in the right groin and these likewise reacted well to roentgen therapy. At this point he developed a cough, and in a short time a left pleural effusion occurred, necessitating repeated aspiration. In September, edema of the thighs, scrotum, penis and buttocks appeared. Dyspnea, wasting, and edema increased, and in October dysphagia became a troublesome symptom, and was finally thought to be due to a ninth nerve nuclear lesion. His condition became rapidly retrogressive and he died in December, 1939.

An autopsy revealed only numerous enlarged nodes in the abdomen and a dense infiltrating mass involving the psoas muscles and posterior abdominal wall. This was diagnosed as a "sarcomatous degeneration" by Professor J. H. Biggart, Institute of Pathology, Belfast, Ireland.

CASE III. This case is one of eighteen years' total duration in a man who had surgical excision of the involved nodes. He was free of symptoms for ten years and died of actinomycosis. At autopsy a minute quiescent focus of Hodgkin's disease was found in one small neck node. H. J., white, male, aged forty-four; occupation restaurant worker. Admitted June 4, 1929. Past history, irrelevant.

On admission to Memorial Hospital patient's history was as follows: He had had a swelling at the base of the right side of his neck for eight years. It was fairly small for the first two years, and then enlarged progressively until eight months before admission. There had been no pain, weight loss, or other symptoms.

The description of the tumor was as follows: "At the base of the neck, posterior to the sternocleidomastoid, is a group of enlarged nodes. The largest is at least 10 cm. in diameter. It feels discrete. It is rather firm, but gives the impression of being cystic in some areas. There are other enlarged, firm nodes beneath it."

An aspiration of the mass revealed only "lymphoid tissue." A roentgenogram of the chest was negative for parenchymal or mediastinal involvement and there was no evidence of disease elsewhere.

On June 17, 1929, the entire right neck mass was resected and histopathological diagnosis by Dr. F. W. Stewart was "classical Hodgkin's disease." Following this, the patient received about 500 r to this area in the right neck. Patient was followed at irregular intervals up to June 27, 1933. At no time during this interval had there been any new evidence of disease and on this examination he seemed perfectly well.

Patient was lost to follow-up for six years and when heard from again was a patient at the New York Hospital. Briefly, his history and course there are as follows: For five months before admission he had been feeling run-down. Six weeks prior to admission he developed a dull pain in the region of the right scapula, and in a short time a productive cough appeared. He had several drenching night sweats. In the hospital a consolidation of the right upper lobe was found and, in the belief that this was a manifestation of Hodgkin's disease, he was given 1,000 r of roentgen radiation to this area. There was no appreciable effect from this and patient ran a septic, retrogressive course. On the sixty-third hospital day he developed a sudden transverse myelitis at the level of T_6, became progressively worse, and died on the seventy-ninth hospital day, December 20, 1939.

Autopsy revealed extensive actinomycosis with liver abscess, empyema, lung abscess in right middle and upper lobes, and osteomyelitis of first and second ribs and of fourth, fifth and sixth thoracic vertebrae. There was erosion into the spinal cord with focal meningitis at this level. Numerous lymph nodes were removed from abdomen, groins, mediastinum, axillae and neck, which were all sectioned, but no trace of Hodgkin's disease could be found. The typical ray fungi of actinomycosis were very

obvious, however. Dr. F. W. Stewart has reviewed the slides on the autopsy material and he believes that there is a focus of Hodgkin's disease in a minute node, the size of a small pea, that was removed from the right neck. There wae no trace of Hodgkin's disease elsewhere in the body.

Case IV. This case is one of sixteen and one-half years' duration with involved nodes in the neck, axillae and groins. The patient has had some pathological condition of the neck nodes since he was nine months of age.

J. Z., male, aged ten; admitted July 12, 1924. Past history, mumps.

Patient was first seen at Memorial Hospital when he was ten years of age, with the history of enlarged nodes in the neck, just below the angle of the left mandible, for seven months. These nodes were painless and had remained stationary in size since first noted. Patient's mother stated that enlarged nodes had been removed from the left neck surgically when patient was nine months of age. We could not ascertain where this was done, nor what the pathological diagnosis was.

The positive physical findings on admission were as follows: "There are several discrete, freely movable, firm nodes in the left neck varying from 1 to 3 cm. in diameter; also several small firm nodes in the left axilla. The spleen was not palpable. The left testicle was undescended." The diagnosis at that time was cervical adenitis, either tuberculous, nonspecific or Hodgkin's. Biopsy was not done. Several suberythema doses of roentgen radiation were given to the left neck and axilla with complete regression. Patient was observed irregularly for the next six years. During this interval, the only evidence of disease was the presence of shotlike nodes in the posterior cervical chains. In January, 1930, enlarged nodes were again present in the left neck and axilla, the largest being 3 cm. in diameter. An excisional biopsy was done and the microscopic diagnosis of atypical Hodgkin's disease was made. The patient received two roentgen treatments at this time to the left axilla, but there is no record of further irradiation to the neck. For the next four years the patient was in excellent health and became rather obese. Small palpable nodes persisted in the left neck, both axillae and groins. In November, 1934, a node the size of an olive appeared in the right posterior cervical triangle. Coincident with this there occurred a moderate enlargement of nodes in the other node-bearing areas. The right neck node was excised, and the pathological report was typical Hodgkin's granuloma.

With this definite diagnosis, patient was given 4×200 r to each cervical, axillary and inguinal region. The factors used were 200 kv., 0.5 mm. Cu filter and 50 cm. target-skin distance. There was satisfactory regression of all the nodes following this course of therapy. For the next eighteen months the patient remained well, but in August, 1935, shotlike nodes were again palpable in the previously treated areas. He was admitted to the Heublein unit and received 75 r of total body irradiation. Patient then remained well for about two years. In April, 1937, a node was felt in the right axilla and enlarged firm nodes were present in the left groin. Patient received 800 r to the left groin and 1,200 r to the right axilla with the 200 kv. machine. The nodes in these areas regressed, but not completely. One year later there were still palpable nodes in these areas.

In May, 1938, the patient had an acute appendicitis and appendectomy was performed. No adenopathy was found in the region of the cecum. In August, 1938, palpable nodes were again present in both upper cervical regions, right axilla and both groins. Patient received 200 r to the right axilla.

The nodes remained unchanged until October, 1939, when two enlarged nodes were found in the right axilla. These were treated individually through small circular portals, 400 r in one treatment to the smaller and 600 r to the larger. There was complete regression with this therapy. Since then there has been no new evidence of disease. Patient has remained in good health and at the last examination, in December, 1940, there was shotlike adenopathy palpable in the various node-bearing areas. At no time during the course of the disease has there been mediastinal widening or splenic enlargement.

SUMMARY

1. Two hundred and sixty-five cases of histopathologically proved Hodgkin's disease are reviewed.

2. The average survival period of all cases in this series from the time of the beginning of therapy is 33.8 months. The average survival time of 211 deceased cases

followed throughout their course is 24.6 months.

3. Of our patients 17.7 per cent survived five years following treatment; 3.4 per cent survived more than ten years.

4. In our series the sex distribution is males 62 per cent and females 38 per cent.

5. There is no correlation between the histopathological picture of a given case and the course of that case.

6. A brief discussion of the treatment routine at Memorial Hospital is presented.

7. Seven cases treated by surgery with good results are presented, two from the literature and five from this series.

8. A tentative definition of the most favorable type of case is made.

9. A discussion of surgical treatment of Hodgkin's disease is given, with the conclusion that in strictly limited Hodgkin's disease involving one group of accessible nodes it may have a more successful result than has been thought, especially if combined with prompt postoperative roentgen irradiation in doses kept within safe limits.

10. Detailed report is made of four cases of Hodgkin's disease of unusually long survival.

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THE PRESENT STATUS OF RADIUM THERAPY*

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WHILE radium is used in a number of inflammatory and hyperplastic conditions, its main value lies in the cancer field. This discussion will be concerned chiefly with its place in cancer therapy.

It is hoped that by setting forth certain of the present day limitations of radium therapy, rather than dwelling upon its accomplishments, before a mixed group of scientists, effort may be stimulated toward solving some of the problems which would enable radium to embrace a wider field of usefulness.

The tremendous advances made during the past few years in the development of equipment for roentgen therapy have rather overshadowed the older source of effective therapeutic radiation—radium. Its adaptability, in conjunction with roentgen therapy, should be more carefully borne in mind by clinicians, especially the roentgen therapists. Many of the younger group of roentgen therapists have grown up with roentgen rays alone. The development of improved equipment, from an engineering standpoint, has been rapid. Progress in the study and adaptation of this equipment to clinical use, both in the laboratory and in clinical practice, has been fascinating, encouraging and time consuming. Some of the men have had little opportunity to study radium concurrently, and many have not taken the time. The result has been a certain lack of coordination in the applicaton of energy from these two sources of radiation in meeting the problems of cancer therapy insofar as radiation therapy is or may be of value.

Few of the malignant neoplastic diseases are manageable to best advantage by one agent or method alone. Radium has certain peculiar advantages to offer in the various combinations of therapy found best suited to the individual case, in the present state of our knowledge of the subject. In immediate conjunction with operative surgery it probably enjoys a more intimate relationship than do roentgen rays. On the other hand, it is capable of close and valuable assistance as a complement to roentgen therapy. Inasmuch as radium does not afford the sole means of treatment in most of the major groups of malignant disease, it does not seem wise, here, simply to enumerate its relative importance in the various groups ordinarily discussed by clinicians.

The various special advantages will be suggested and their adaptation to certain fields of cancer presented.

In ordinary practice, there are three general methods of application: external or surface, intracavitary, and interstitial.

External radium usage may be by surface contact or near surface applications, and distant exposure of large amounts of radium, usually referred to as telecurie therapy. The former method is for treatment of skin lesions and can, for the most part, be duplicated with roentgen rays. There is perhaps one point worthy of special mention in this connection. One of the first practical clinical applications of physical principles to radium therapy had to do with the treatment of skin growths. It was found that a small skin lesion responded better to a larger amount of radium at, let us say, 1 cm. distance, than it did to a lesser amount in contact—other factors being duly compensated for. The scar was more satisfactory and the degree of permanence greater. Furthermore, if the 1 cm. distance application was heavily filtered—0.5 mm. of platinum equivalent or greater—the result was still better than the same distance with minimum filter and correspondingly lesser amount of radium used. This extremely elementary fact is possibly too much overlooked or ignored today by those especially interested in using low voltages and light filters with roentgen rays for the treatment of accessible major types of cancer.

The term telecurie therapy is apt to be

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applied to radium exposures at any distance beyond 3 or 4 cm. This becomes confusing. These intermediate distances for treatment at depth are less efficient than ordinary 200 kv. roentgen rays with the rather minimum factors of 50 cm. distance and 0.5 mm. Cu filter. The term should be reserved for radium distances beyond 10 cm. where the absorption at depth is at least within a comparable range with 200 kv. roentgen rays. It is only with large amounts of radium beyond 10 cm. distance that radium and roentgen rays approach a possible comparative or competitive position, for external therapy. The largest amounts of radium so far available for use in this manner have been a few 4 and 5 gram packs or bombs. These amounts are not large enough to permit, in a practical way, of distances beyond 15 or 20 cm. The time factor is entirely out of comparative range for trial with 200 kv. roentgen rays, much less the higher voltages. Very large amounts of radium for use in this way are economical impossibilities. There is a possibility of solving this problem through production and use of radioactive compounds in large amounts. There is an impression of superior clinical benefit for the 4 or 5 gram pack among some of us who have had experience with it. The prolonged exposure time is an admitted advantage, yet it does not make complete explanation. The question of selective action has many arguments against it and yet the problem remains unanswered.

The last word has not yet been spoken on the relative value of telecurie therapy. The experimental work of Failla and Henshaw, together with their collaborators, on the relative effectiveness of radium and roentgen rays on wheat seed germination leaves an impression rather in line with clinical experience with a large radium pack.

The conclusion of Friedman and Rosh, after studying a large radium pack, a small pack and 200 kv. roentgen rays comparatively, was that continuous irradiation with the small pack represented the most effective method of external therapy. This took into account only 200 kv. roentgen rays and was done in connection with their study of possible rhythmic effect of radiation. The entire answer may be the continuous exposure. Yet, it leaves radium in the field of external therapy. In spite of the steadily increasing roentgen-ray voltages, telecurie therapy still deserves further investigation, if and when very large amounts of radioactive compounds can be produced economically and used with reasonable safety from the standpoint of the investigators.

We have, for many anatomic locations, means of supplementing external therapy—roentgen rays or radium—in order to bring about complete regression of the local manifestation of malignant disease. In many of these conditions present day external therapy is almost, but not quite, capable of producing the complete desired reaction. The margin between success and failure is often narrow. External irradiation is one of the ideal forms of local therapy. Hence, any advance through an improved telecurie therapy would be most welcome.

The second general method of radium application—intracavitary—approaches more nearly its real place in present day therapy. It affords a source of powerful energy in small bulk which can be placed in the body cavities for intense local irradiation.

In treatment of carcinoma of the uterine cervix it has given outstanding results, especially in the clinical Group 1, and has replaced surgical removal entirely. I specify carcinoma of the cervix uteri, not only because it is the foremost major group of cancer in which radium is unusually effective, but because it offers features especially suitable to this means of radium usage. It is directly accessible under direct vision. It is manually palpable to determine the gross extent of disease. It is a thick walled structure with excellent blood supply and it is relatively insensitive to pain. There is no reasonable limit to the length of time the radium applicator may be kept in position. I specify clinical Group 1 as giving best results in order to exemplify the limited range of effective irradiation by this method even with the heaviest of practical filters.

The results of radium irradiation alone of carcinoma of the uterine corpus are better

than we at one time anticipated. However, in this location the growth is beyond the range of direct vision so that an element of uncertainty attends the application. To overcome this and to assure a practical filling of the available space, Heyman has met the technical problem by practically filling the intra-uterine cavity with many heavily filtered tubes of radium. The factor of relative uncertainty, as to accuracy of placement, is, however, obvious as between uterine cervix and corpus. To be effective, radium must be very accurately placed. The matter of precision is just as great as in the most meticulous surgical procedure. Because of the uncertainty of localization in the corpus, some gynecologists, probably most, prefer to follow the radium application by hysterectomy. If not supplementing by operation, then most certainly by roentgen therapy either before or after the radium. I have not taken the time to point out the relationship between response to irradiation (radium or roentgen rays) and degree of cellular differentiation of the tumor. An understanding of this is assumed. Having discussed the effects of radium irradiation of the uterine cervix and corpus from the standpoint of some of the reasons for the favorable response, it is not difficult to visualize the probable results in other body cavities.

Intracavitary radium application requires accurate placement in a location where it may remain undisturbed for many hours at least. The effect is intense but local —even with the heavy filtration essential to this type of therapy. Even the urinary bladder does not lend itself to successful therapy by this means, limited though its space may be under circumstances of growth.

In the entire gastrointestinal tract radium is of negligible value until the lower sigmoid and rectum are reached. The predominant type of growth is relatively radioresistant, in addition to the other obvious technical obstacles. In the lower bowel, however, a great deal has been accomplished, especially with the aid of roentgen therapy. Benefit through radiation in this location is usually thought of in terms of palliation. This is probably true as far as the locally advanced stage of the disease is concerned, although there is an appreciable percentage of complete regressions at this stage. However, the work which Binkley has done by intracavitary radium irradiation in early accessible rectal cancer is, in my judgment, outstanding in the rectal field. By using a special technique and specially adapted applicators, he has a brilliant series of cured cases. The importance of the work is not limited to its face value. He has shown by this work that it is the early case which is most benefited, thus avoiding radical surgery. It refutes the all too prevalent idea that irradiation is for palliation or occasional salvage of the advanced case. It shows that painstaking attention to detail and accuracy is as essential in radium therapy as it is in major surgery.

The intracavitary use of radium has, for the most part, accomplished its result through a single exposure. The amounts applied in this manner have been those available, or large amounts by preference, to minimize discomfort for the patient or economize on bed space in the hospital. The optimum exposure time has not been given the attention it deserves. The work of Friedman and Rosh on what they choose to term the rhythm of radiation effects is impressive. Their work has had to do with external irradiation but there is no reason why intracavitary applications, especially in the pelvis, might not be much more effective if and when an optimum period of exposure is established. Binkley's multiple dose method in the rectum is certainly a step in that direction. My experience with intra-uterine irradiation has been much more favorable with smaller amounts over several days rather than larger amounts for twenty-four to thirty-six hours.

The general method to be considered next follows directly along this plan.

The principle embodied in intracavitary irradiation is carried a step further in interstitial or intratumoral irradiation. Here, radium element in metal needles or radon in mental implants is inserted directly into and about the tumor bearing area. Experi-

ence has fairly well established the dosage levels. The wide range of applicability is so well known, or so obvious, that detailed amplification is unnecessary here. The method has made possible the control of cancer of various types and in many locations not otherwise completely responsive to external or intracavitary irradiation. It is practically always complementary to some type of the other forms of radiation. It is of tremendous value as a complement to operative surgery at the actual time of operation. It may salvage an operative procedure which would otherwise have been a failure through inability to carry out a complete removal, or the operative procedure may have been solely for the purpose of permitting proper localization of the needles or implants. This method has a real place in the care of practically every major group of cancer—the primary epidermoid carcinomas of the mouth and pharynx, their cervical metastases, the axilla in some breast cancers, even some primary breasts, the bladder, prostate, some carcinomas of the cervix uteri, the inguinal metastases of carcinoma of the external genitalia, and various other growths. Indeed, it is my firm conviction that practically no surgical procedure on a growth of questionable operability should be undertaken, in all fairness to the patient, without a proper supply of radium, in suitable form, available to aid in the possible salvage of a difficult situation.

In this connection, it is only fair to say that there are hazards to implantation. These hazards usually center round a disregard for infection or the possibilities of subsequent infection. For example, implantation in a closed space such as the maxillary antrum should not be done without definite or tentative plans for subsequent surgical drainage. For the same reason, I have always opposed the use of implants in such locations as the esophagus or bronchial tree.

There is no particular reason for controversy between radium element needles and radon implants—seeds. Up to a certain point it is a matter of individual experience and available supply. The radium element needles have the advantage of a slightly greater filtration and are more universally available in small unit holdings of radium, too small for emanation collecting equipment. They are precluded in various surgical procedures because the necessity for subsequent withdrawal interferes with surgical wound healing. In some locations where implantation is desirable, the needles cannot with certainty be retained in position for the requisite length of time. The radon seeds have a much wider range of applicability—they require no withdrawal. The period of irradiation is more prolonged. The filter is slightly less—0.3 mm. gold is universal—if indeed the lesser filter is a disadvantage! Other metals as a filter have been tried, especially silver and lead. They have no advantages over the gold and some disadvantages.

The chief reason for using a considerable number of needles or seeds in a given case is to minimize and distribute zones of focal necrosis about individual containers, thus avoiding a surgical complication. From a physical standpoint a spherical tumor is as efficiently irradiated from a point source at its center, but the localizing of all necrosis at this point would quickly become serious if the tumor were of any size.

In discussing needles and seeds for implantation, the reference to the degree of filtration would imply that the therapeutic value rests with the gamma radiation. The trend with roentgen rays is toward higher voltages and increased filtration. Radon in 0.3 mm. gold seeds has been used for implantation since 1925. Prior to that, radon in glass capillary seeds was used from 1916 to 1925. The gold filter reduced the secondary tissue necrosis and permitted of a corresponding increase in gamma radiation. However, as I look back over some of our old material, I am impressed by the permanence of the results and the very fine pliable scars with excellent blood supply, superior to many of our gold seed scars. I am conscious of our interim-acquired experience in the supplemental handling of these cases, especially in the control of local

infection. Local infection plays a great part in all irradiation necrosis. I wonder if our unfiltered seed dosage might not have been improved upon. I am not advocating a return to the hard beta and soft gamma radiation of the unfiltered seed but I am wondering if, in our rush for shorter wave lengths, a pause for reflection in retrospect might not be advantageous. This would seem an appropriate time for review of some of our older experiences in view of the possibilities being opened up to us through production of the various radioactive compounds.

In its intimate application within tissues, radium has never, in a practical way, gone beyond the interstitial implant or point source of radiation.

In 1917 the late H. H. Janeway visualized radium as a possible constitutional therapeutic agent. Failla exposed ordinary table salt to radium emanation in a closed chamber of the emanation collecting apparatus. This was measured, in the same manner as were all radon preparations, in terms of millicuries. The salt was dissolved in sterile water and I injected it intravenously in a small group of Hodgkin's disease and leukemias. There was no obvious benefit in Hodgkin's disease. Our blood check-ups were crude as compared with the present. However, there was a pronounced effect in the leukemias. We established a maximum tolerance dose of 250 mc., as we were measuring it. One advanced and active lymphatic leukemia with generalized nodes showed a complete regression of symptoms for a year from one such dose. The method was tedious and soon proved to be dangerous to the operator. We gave it up. It is of interest in view of the work now being done with radioactive substances produced through the agency of the cyclotron.

So far, tumor tissue and normal tissues have been on an equal footing in response to or resistance to a given amount of radiation. Advances with radium have depended largely on adaptation of the various physical factors to the individual problem. Dosage, for the most part, has, of necessity, been the maximum that the normal surrounding tissue structures would tolerate. There has been no secondary or complementary method or agent which would render the tumor tissue more sensitive to irradiation. There has been no means of retaining more of the ionizing radiation within the tumor bearing area. There has been no means of directly increasing the resistance of surrounding normal tissues to irradiation.

It was transiently hoped a few years ago that colloidal lead might prove to be of value through partial destruction—desensitization—of the tumor mass. The general toxicity of this product soon dispelled the hope. Further investigation is needed toward finding a method of pre-irradiation therapy which will render the tumor bearing area more sensitive to irradiation; or a substance, itself inert, which will localize within the tumor bearing area and increase the degree of ionization when the zone is irradiated.

Failla has shown that the ionizing effect can be enhanced by injecting sterile water into the tumor after the radiation has been delivered and while the ionizing effect is developing. The difficulties, of course, are with uniform distribution within the tumor and control of diffusion outside.

The interstitial use of radon was limited to multiple point sources—glass and later gold seeds—because it was impossible to control the active deposit on salt, injected in aqueous solution, to the desired area, for any length of time. The active life period of radon for such a procedure was too long. The danger of pressure necrosis from fluid bulk, especially if a vasoconstrictor was added, was a factor. The uniformity of local fluid diffusion is always open to question. However, these efforts were all by local injection. The work now just opening up with short lived radioactive substances, some of which have a predilection for certain tissues offers a wide field with innumerable possibilities. The immediate association of iodine and the thyroid is a little disconcerting at the moment when it would seem the selective response is much greater in the hy-

perplastic than in the neoplastic thyroid.

When we consider the number of compounds studied in other epochal phases of medicine before hitting upon the effective one, we must realize the amount of work with its innumerable disappointments as well as the vast possibilities attendant upon the future study and use of the radioactive isotopes. While this is not radium therapy, the work with radium furnishes a substantial background from which the other may go on.

In our search for ways and means of rendering tumor tissue more sensitive to irradiation and normal tissues more resistant, even though slightly, we must not lose sight of the biophysiological factor. It has long been known that an optimum response to a given amount of radiation does not occur in the presence of a secondary anemia or in the presence of that major factor in the production of secondary anemia in the cancer patient—low grade mixed infection.

In other words, the optimum response to therapy is attained only in a patient whose general appearance and sense of well being is at a high level and who is physiologically in balance.

Those of us who have been aggressive during the past few years with liver and vitamin therapy along with free use of blood transfusions to support our specific radiation therapy are convinced of the value thereof.

In our search for tumor sensitizing and selective action agents and normal tissue resistance builders, there is a wide field for further careful investigation in a systematic study of the anti-anemic preparations, vitamins and specific hormones.

SUMMARY

1. The rapid advances in development and application of equipment for roentgen therapy have tended to somewhat overshadow the usefulness of radium to a point where coordination of usage of the two sources of energy is not as close as it should be.

2. Cancer therapy is dependent upon a close and complementary relationship between surgery, roentgen rays and radium.

3. Three general methods of radium usage have been outlined and discussed—external, intracavitary and interstitial.

4. The question of the selective action of gamma rays of radium has again been raised.

5. The possibility of benefit from beta and soft gamma rays, used interstitially, is mentioned—based on early experience with unfiltered glass implants.

6. Early experience with intravenous use of an aqueous solution of active deposit of radium is cited.

7. The need for methods of rendering tumor tissue more sensitive to irradiation, selective agents and means of increasing normal tissue resistance to irradiation is stressed.

8. The possibilities of the artificially produced radioactive compounds are mentioned.

9. The enhancement of radiation effect through vigorous use of anti-anemic medication, vitamins and specific hormones is pointed out as another new field for continued investigation.

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LEADED RESINOUS APPLICATOR FOR INTRAORAL AND EXTRAORAL RADIUM THERAPY*

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ONE of the great problems in the proper treatment of precancerous leukoplakic areas and true cancerous lesions occurring within the mouth and adjacent cavities is the avoidance of injury to the surrounding tissues. The application of external and internal roentgen irradiation to the affected parts has given excellent results in the treatment of intraoral cancer. Extensive epithelitis of the face with subsequent sloughing and permanent scarring and disfigurement has frequently occurred. In many cases roentgen irradiation alone has failed to clear up the malignant condition but has delayed the fatal progress of the neoplasm.

The use of radium is highly successful and practical in the treatment of oral cancer. However, in many instances it has been difficult to protect normal structures from the effects of radium rays because of inadequate applicators. Distance is an ever ready filter, but in the limited oral cavity one cannot always obtain sufficient space from the radium to protect normal structures. In such cases, lead or other absorbing substances must be used to prevent damage to bone and to soft tissue. The applicator should be comfortable to the patient and easy to insert, adjust and maintain in position. In the past, radium has been used in platinum needles implanted and sutured in the lesion, in radon seeds implanted, in platinum or other metal tubes held in position by some usually inadequate appliance. With the above conditions ever present, the necessity for an adequate and practical radium retaining device has brought about the introduction of leaded acrylic resinous appliances for intraoral and extraoral therapy.

One of us (J. E. P) designed and constructed this new applicator; another (V. F. J. B.) used it for the first time in treating a patient at the Johns Hopkins Hospital. The applicator was developed independently and without knowledge of any other similar appliance. In reviewing the literature one finds few references to similar devices. Ackerman[1] for a long time has used a combination of lead and vulcanite rubber shields for protection of normal tissue while diseased areas are being irradiated with gold radon seeds. Many radium therapists have for years used dental compound for holding radium in the mouth; but the exposure of the technician was too great and the protection of the patient inadequate.

The Pyott applicator has a wide range of usefulness. It is built not only to protect normal structures but to hold radium or radon preparations accurately against the area to be treated. It is of special value to those who use radium element and do not have access to radon seeds. Also, it is frequently impossible or inconvenient to implant radon seeds in certain locations. The leaded resinous radium applicator, then, serves two main purposes: it holds the radium preparations accurately in place and it protects normal surrounding structures.

The base of this applicator is an acrylic resin. Acrylic resin is an amorphous mass obtained by the polymerization of acrylic acid: C_2H_2COOH, methacrylic acid $C_2H_2(CH_3)COOH$, or particular esters of these

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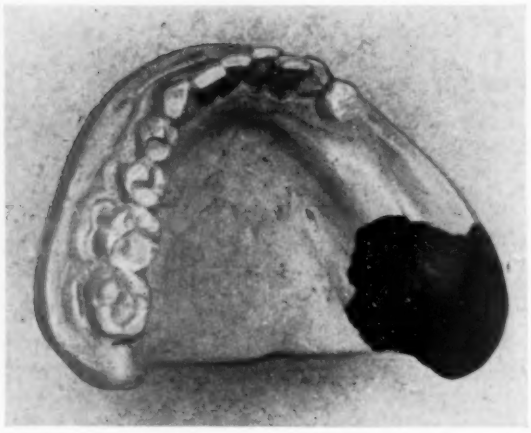

FIG. 1. Stone cast with cancerous lesion outlined.

acids. The resins are prepared by manufacturers in one of two forms: In type A, the polymer is already plasticized with the monomer in proper amounts by the manufacturer. In type B, the polymer is supplied as a powder, and the liquid monomer is in a separate container. In the latter case, the dentist mixes the powder and liquid together in the proper proportions just before it is to be packed. The resinous mass is cured when heat or light causes the monomer to polymerize, thereby linking the partially dissolved polymer particles together into a homogeneous mass. The resultant product is a hard, dense, and clear substance. This material is easy to manipulate in the manufacture of these acrylic applicators and enables one to incorporate within this substance metal—for instance, lead—which will absorb gamma radiation and prevent it from reaching tissue that should not be irradiated. The material is transparent to ultraviolet light to a rather high wave length (Skinner[2]).

Acrylic resins, marketed under the trade names of lucite, vernonite, lucitone, crystolex, etc., permit the transmission of the gamma rays in the same proportion as that of glass, etc. Inasmuch as the acrylic resin will absorb the alpha and beta rays, it is probable that it will also absorb the secondary radiation from the lead used in the applicator. Through personal communication with Dr. John E. Rose[3] we learned that when the acrylic resin is sufficiently thick—1 cm.—it will filter out the secondary radiation from the lead used in the applicator.

Preparation of the Mouth. The mouth must be cleaned and prepared for the necessary therapy. Irradiation often brings about the devitalization of teeth and bone adjacent to the cancerous lesions. It has been found advantageous to remove obstructing, carious and infected teeth in and near the neoplastic area.

Technique. The leaded acrylic resinous radium retainer to be described was first designed to treat a cancer in the lower molar and retromolar fossa of the right mandible following a tooth extraction. A hydrocolloidal impression of the cancer and of the remaining teeth is obtained. If the patient is edentulous, a full-mouth impression must be taken including the cancerous area. Casts are made of artificial stone and a pencil outline of the area to be irradiated is traced on the cast (Fig. 1).

The necessary retention of the appliance is accomplished by a lingual bar and clasps attached to the remaining natural teeth. The saddle to be used as the floor for the radium retainer is first made in wax, care being taken to adapt only a 28 gauge thickness of wax over the outlined area of the

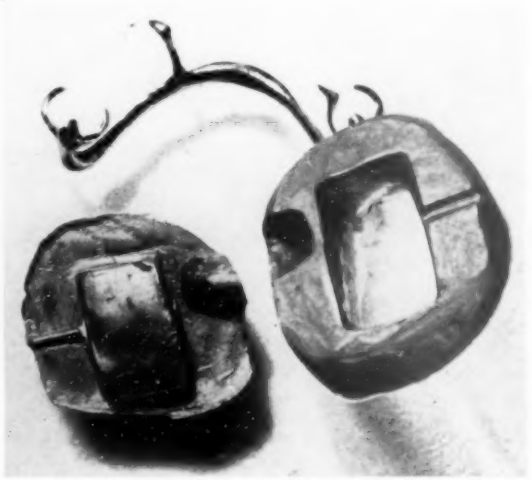

FIG. 2. Cast bar and clasps attached to acrylic base with protective leaded chamber and lid.

cancerous lesion. A shoulder of wax which is much thicker is placed at the periphery in order to hold the lead protective chamber.

This waxing is invested in a dental flask; the duplication is made of acrylic resinous substance. Upon this, the necessary lead protective chamber is first designed in wax. The dimensions of this particular lead protective chamber are: length, 2 cm., width, 1.8 cm., and depth, at least 1 cm. The desired thickness of the protective lead between the radium tubes and the adjacent normal structures should be 5 mm. or more.

This wax pattern is removed from the acrylic base and duplicated in pure lead. The protective lead chamber is cemented to the acrylic base. Additional retraction of the normal tissues is accomplished by the placing of acrylic resin on the exterior of the protective lead chamber. A lid for the radium chamber is designed in wax and also duplicated in pure lead. This lid must be at least 5 mm. thick (Fig. 2).

This applicator is now ready to be inserted in the patient's mouth for trial. Any irritating or traumatic condition of the saddle is relieved by grinding the base with vulcanite burs or carborundum stones until the applicator is comfortable when in place. These areas must be repolished. The patient is instructed in the manner of insertion and removal of the appliance, to assist the radium therapist during treatment.

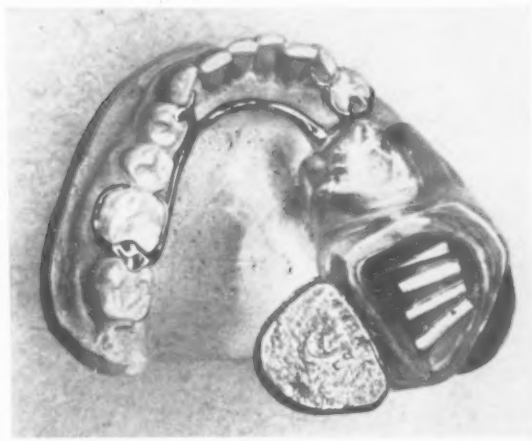

Fig. 3. The radium applicator is mounted on cast showing correct position of radium tubes within radium chamber.

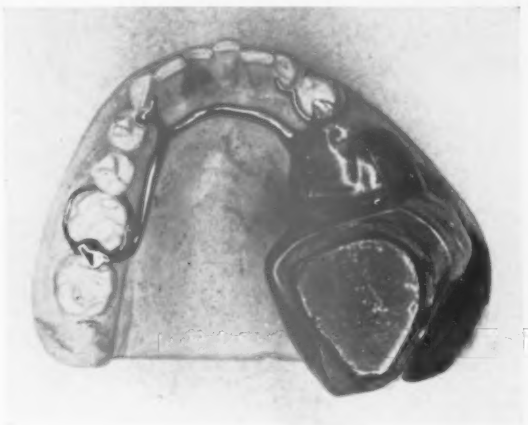

Fig. 4. Applicator with lid sealed securely is ready for insertion

There is no objection to irradiation by means of deep roentgen therapy while waiting for the applicator to be prepared. This preliminary roentgen therapy will frequently clear up infection and make radium irradiation easier. Any combination of roentgen and radium therapy should be worked out and adopted as soon as the diagnosis is made.

In the average case this applicator can be made within a period of forty-eight hours. The applicators made without gold bars and clasps (Figs. 7, 10 and 11) are inexpensive. Material costs between seven and ten dollars, depending on the amount used. With cast clasps and bars the cost is approximately twenty-five dollars for materials.

When the patient is ready for intraoral radium therapy, the appropriate radium tubes are placed inside the radium chamber about 2 to 3 mm. apart and so arranged as to give uniform irradiation to the diseased area. Beeswax holds the tubes in the correct position and they are made further secure by allowing a few drops of molten wax to fall on them (Fig. 3). The lid is then put in place and sealed by a thin layer of molten wax (Fig. 4). After insertion of the applicator, a piece of rubber dam 2 or 3 mm.

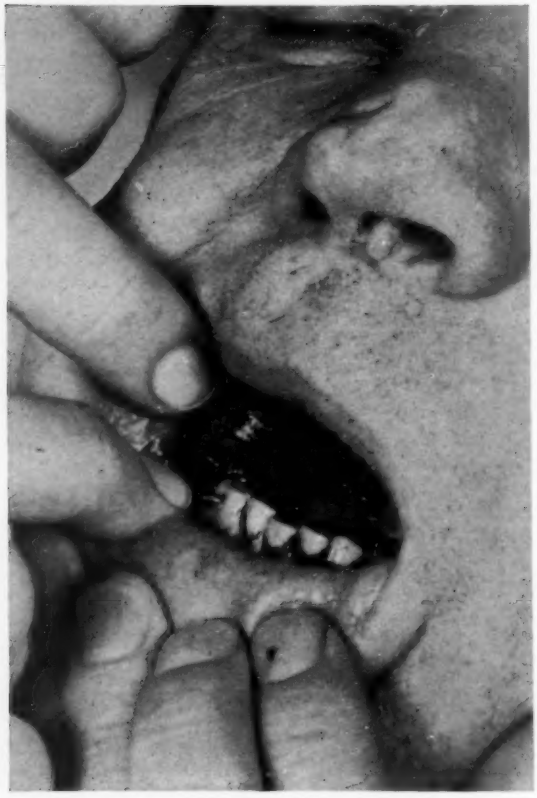

Fig. 5. Leaded resinous applicator for intraoral radium radiation inserted into the mouth.

thick may be placed on each side of the appliance in order to screen off any secondary radiation from the lead. A thin layer of wax over the lead serves the same purpose (Fig. 5).

From our experience, we have found this appliance to be highly successful in the treatment of cancer. It is of universal value from a radium therapeutic and application standpoint. For oral neoplasms, it is easily inserted and removed. It is safe for the therapist since it requires but a minimum of direct handling, and is safe for the patient since its construction permits application in the same position at each treatment. These applicators can be made for and are easily and effectively used in the treatment of external lesions that are impressionable.

The following two case studies show both the internal and external application of a leaded resinous radium retaining appliance.

Case 1. S. G., Male, aged forty-five, first reported to the Dental Clinic of the Johns Hopkins Hospital ten weeks following the extraction of a loose lower right first molar. According to the patient, his post-extraction course had been very troublesome. The socket did not heal and there was a continuous purulent drainage from the lesion. The patient returned to his dentist thrice weekly following the extraction, and the bony socket was irrigated and forcibly curetted, a procedure attended with great pain.

After ten weeks of such treatment, the patient reported to Johns Hopkins Hospital. A lateral roentgenogram of the right mandible showed some osteoclasia present due to curettage, but the examination was negative for osteomyelitis.

The patient was referred from the Dental Clinic to the Department of Radiology for consultation and was seen there by one of us (V. F. J. B.), who suggested radium therapy with the aid of leaded resinous appliance.

When the patient was first seen in the Department of Radiology, examination of the mouth revealed the presence of an ulcerative lesion about 1.5×0.8 cm. involving the area at the junction of the anterior and posterior halves of the right lower gum. The ulcer, about 5 mm. deep, was covered with a grayish-white exudate. The posterior half of the gingival mucosa was reddened and edematous; there was also evidence of considerable secondary infection. There was a definite fetor oris. The nasopharynx and tonsils were negative and the sinuses transilluminated well and clearly. In the region of the right submaxillary gland, there were small, non-tender, palpable nodes. A culture and smear of the ulcerative area were taken, the latter being positive for Vincent's infection, the former showing a growth of alpha streptococci and *Staphylococcus aureus*.

A biopsy of the tissue showed squamous cell carcinoma. The lesion included the alveolar area of the lower right second bicuspid and molar regions and extended slightly into the nasopharynx.

Pending the construction of the applicator the patient received deep roentgen therapy to the lesion extraorally.

During this period, the lower right second bicuspid and upper right second molar were extracted. The patient's teeth were given an extensive scaling and prophylaxis. An impression was taken of the upper and lower arches with a hydrocolloid material, and stone casts were

made therefrom. The casts were duplicated and the appliance was constructed as outlined previously.

The radium treatment was planned and given as follows: four 25 mg. radium tubes were placed side by side in the appliance, each about 2 mm. from the other with the long axis of the tubes at right angles with the long axis of the jaw. Each tube had an actual length of 15 mm. and an active length of 9 mm. The wall thickness (filtration) of each of the tubes was 1 mm. of iridium-platinum. The total quantity of the radium (element) in the tubes was 100 mg.

The appliance remained in situ for one hour on the first day and for two hours on the second, third, fourth and fifth days, and for one hour on the sixth and last day, giving a total of 1,000 mg-hr. The distance between the radium tubes and the lesion was about 2 mm. A piece of rubber dam 5 mm. thick protected the buccal mucosa and the tongue immediately adjacent to the radium containing appliance.

During the week following treatment the patient experienced some soreness at the site of the lesion. Inspection disclosed considerable reddening of the mucosa about the area that had been treated and also on the soft palate, but there was no frank evidence of mucositis. At a later examination there was a small amount of slough about the lesion, and the last examination revealed complete healing.

Fig. 6. Parts of resinous applicator for external radium radiation: *a*, acrylic base of retainer; *b*, aluminum foil to be placed between acrylic base and lead protective chamber, *c*, lead protective chamber; *d*, lead lid.

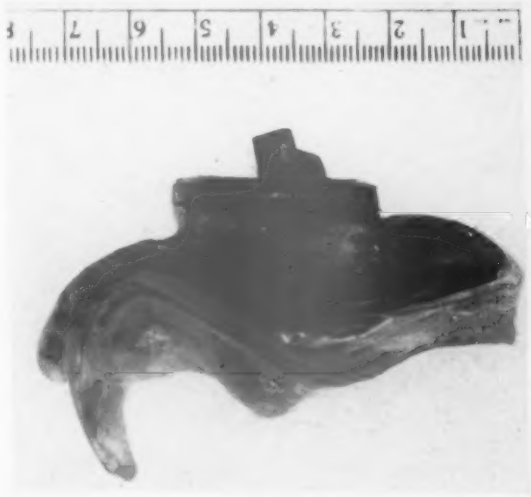

Fig. 7. Assembled resinous applicator with radium tubes placed within chamber, ready for external radium radiation.

It might be mentioned here that not all cases are given pre-radium deep roentgen therapy, although such treatment might well follow it. In this case, however, it was decided to begin immediately with deep roentgen therapy in view of the period of time which had elapsed between discovery of the lesion and the admission of the patient to the hospital. Aside from

Fig. 8. Frontal view showing leaded resinous radium applicator in proper position for external radium therapy.

FIG. 9. Lateral view showing leaded resinous radium applicator in proper position for external radium therapy.

the biological effects that such irradiation might have on the tumor growth, it was also considered advisable to use roentgen therapy because of the infection present in the mouth. Treatment was directed to the lesion through the skin of the lower jaw. An elaboration of the technical factors used will not add to the substance of this paper and so are omitted.

CASE II. B. L., Male, aged fifty-five, first noticed two years ago a small scale-like area near the inner canthus of the left eye. The area suddenly became worse and four months ago it was "cauterized." It did not heal.

This patient whose physical examination is recorded was referred to one of us (G.E.W.): "General appearance is good. There is a little clean ulcer at the inner canthus of the left eye, with a rather deep sinus at the lower end. Around the ulcer, the skin is elevated and more or less lobulated. The entire lesion measures approximately 10×17 mm. It is not adherent to the bone and is beginning to encroach upon the inner canthus of the left eye. It does not involve the tarsal plate. Pathological diagnosis: Basal cell epithelioma, inner canthus, left eye."

FIG. 11. Assembled right mandibular applicator loaded and mounted on stone cast illustrating position when placed in mouth.

As this neoplasm would respond well to irradiation, the use of a leaded resinous applicator was indicated.

A hydrocolloidal impression supported by dental compound was taken upon lubricated facial tissues consisting of the left eye (with lid closed) and the bridge of the nose, including the right canthus. A stone cast was made from this impression and duplicated.

Upon the cast the acrylic resin base was designed and constructed. The leaded protective

FIG. 10. Right mandibular area applicator showing cast, lead lid, lead chamber and acrylic base. Applicator made without cast bar and clasps. This type costs less to make than the one illustrated in Figures 2, 3 and 4.

chamber and lid were designed and made. A thin layer of aluminum foil was placed to further filter out the secondary radiation from the lead (Fig. 6). This extra precaution may not be necessary. As stated above, the acrylic resin absorbs the alpha and beta rays, but at the time of treatment we were not sure whether it would actually absorb the secondary characteristic radiation from the lead. Since the treatment we have been assured by Rose[3] that the acrylic will absorb this secondary beta radiation from the lead when sufficiently thick; and we have discontinued the use of aluminum foil. The radium tubes were put in the radium chamber and sealed (Fig. 7). The applicator was placed in position and held securely with adhesive tape (Figs. 8 and 9).

Through the use of the leaded resinous applicator, the radium therapy was administered in the following manner:

December 27, 1940	Amount: 20 mg. Distance: 1 cm. Filtration: 1 mm. each of platinum and aluminum foil plus thickness of acrylic resin saddle Time: 6 hr. Dose: 120 mg-hr.
December 30, 1940	Amount: 60 mg. Distance: 1 cm. Filtration: same as above Time: 7½ hr. Dose: 450 mg-hr.
January 3, 1941	Time: 7¼ hr. Dose: 435 mg-hr. Other factors same as above

Total dose: 1,005 mg-hr. equal to 6.50 threshold erythema doses.

The time factor can be lessened by using more radium and a shorter distance. One centimeter distance was used in this case to have the radium well up in the lead chamber where the wall was thick enough to protect the eye. Two weeks following the above total dose of radium radiation, the patient returned; he showed only a slight reaction and much improvement. Eight weeks from the last application the lesion had healed with only a slightly thickened scar as an indication of the site of the growth.

SUMMARY

The advantages in the use of the appliance described can be summarized as follows:

1. The position of the apparatus during treatment, and during subsequent treatments that have been planned, remains constant.

2. The applicator makes possible radium therapy by a broken dose method, much preferable to the usual single massive dose method.

3. It is not necessary to "unload" the apparatus after each treatment; hence exposure factors for those handling the radium are cut to a minimum.

4. However if it is desired to use the radium on other patients between treatments with the Pyott applicator, unloading and reloading are accompanied by a minimum of exposure to the technician.

5. The radiation can be directed to the lesion specifically and irradiation of the surrounding healthy tissues avoided.

6. The patient is comfortable, is able to move about, and can relieve himself of excessive salivation without fear of changing the position of the apparatus.

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THE USE OF RADON OINTMENT AS A MEANS OF DIFFERENTIATION BETWEEN RADIONECROSIS AND RECURRENT CARCINOMA*

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THE radiotherapist is often confronted with the perplexing problem of deciding whether a given cutaneous or mucosal lesion, in a previously irradiated area, is a late radionecrosis or a recurrence of the malignant lesion for which the radiotherapy was originally administered. This differentiation is all important from the prognostic as well as therapeutic standpoint. If the lesion is recurrent cancer, radical therapy is indicated in the form of extensive surgical removal or further irradiation, depending upon the radiotherapy previously administered. On the other hand, if one is dealing with a late radiation necrosis further irradiation is contraindicated.

Clinically, it is often impossible to differentiate between these two groups of lesions. In general, recurrent epithelioma will be firm to stony hard in consistency, slightly or not at all tender. Firm or hard regional lymph nodes may be present as confirmatory evidence. The outstanding characteristics of late radiation necrosis are local pain and exquisite tenderness. Usually there is a sharply defined ulcerated lesion which may show periods of slight but definite temporary regression if one dares to observe the lesion for a prolonged interval before resorting to biopsy. The clinical features of these lesions are nevertheless confusing and deceptive. Recurrent epithelioma may at times be excruciatingly painful and, conversely, radionecrosis may be present without pain or tenderness. There may be local lymph nodes in association with a radiation ulcer which are inflammatory rather than neoplastic.

Biopsy would appear to be the obvious solution. There are, however, several shortcomings inherent in this procedure. First of all, the histopathological findings in radionecrosis are frequently very atypical as are the findings in a cancer subjected long previously to heavy irradiation. Obliterative vascular changes are usually present in both conditions. Bizarre edematous cells which are the result of prolonged ischemia in a radiation ulcer may be mistaken for tumor cells. No doubt most radiotherapists, like ourselves, have encountered such lesions in which the pathologist's report is evasive and non-committal even after multiple biopsies. Furthermore, repeated biopsy in an area of radionecrosis will further jeopardize its already attenuated blood supply and we have had the uncomfortable experience of seeing minute late radiation ulcers transformed into lesions of much more serious magnitude following biopsy.

Since 1928, one of us (E. U.) has successfully employed radium emanation collected in vaseline for the treatment of injuries produced by the injudicious application of roentgen rays or radium. The technique of application and therapeutic results have been reported in detail in previous publications. A summary of our experience during the last three years and a new method of preparing the ointment impregnated with radon† will be published shortly. So successful has this method of treatment been in promoting granulation and epithelization in radiation ulcers that in a number of instances when such response did not take place we were able to postulate and ultimately confirm the presence of roentgen cancer as a complication of the radiation ulcer. Recently we have employed this method of radon ointment therapy in the attempt to differentiate between late radia-

† The apparatus now being used for the preparation of the ointment is described in this number of the JOURNAL in the article by Hans Kohn-Richards.

* From the Tumor Clinic of the Michael Reese Hospital, Chicago, Illinois.

tion necrosis and recurrent epithelioma (in contradistinction to roentgen cancer). The results have been so eminently satisfactory that two cases so treated are reported in detail.

REPORT OF CASES

Case 1. D. W., white male, aged fifty-two, was referred to the Tumor Clinic on August 25, 1938, for treatment of a lesion of the mucous membrane of the lower lip (Fig. 1). This had been present for eight months. Biopsy revealed a well-differentiated squamous cell carcinoma.

Fig. 1. Case 1. Epithelioma of lower lip before treatment.

Wassermann and Kahn tests were negative. Surface radium therapy was given for this lesion from August 27 to September 5, 1938. A special mold was prepared for the treatment of the lesion and loaded with ten 5 mg. radium tubes placed adjacent to one another and filtered by 1 mm. of platinum. The radium was maintained at a distance of 7 mm. from the lesion. An adequate zone of surrounding uninvolved tissue was included in the irradiated surface which measured 12 square centimeters. Two hundred and fifty milligram-hours was administered daily for ten consecutive days for a total dose of 2,500 mg-hr. This amounted to 1.6 millicuries-destroyed per square centimeter.

An intense epithelitis developed within two weeks and persisted for over a month. Within three months following treatment complete healing had taken place (Fig. 2). The patient was then followed at frequent periodic intervals and remained well until September 13,

Fig. 2. Case 1. Lesion healed following surface radium therapy.

1940. At this time he returned presenting the ulcerated lesion indicated in the photograph (Fig. 3). This had been present for three weeks and was extremely painful. There were no palpable cervical lymph nodes. The ulcerated lesion of the mucous membrane of the lip measured 5 mm. in diameter and 2 mm. in depth. The border was firm in consistency and the center covered by a yellowish necrotic slough. The lesion was very tender to palpation. The question of biopsy was considered to determine whether the lesion represented recurrent epithelioma or radionecrosis. Prompted by our experience in the treatment of radiation ulcers it was decided to attempt several applications of radon ointment at weekly intervals before resorting to biopsy. The patient received three

Fig. 3. Case 1. Ulceration of lower lip two years after irradiation.

Fig. 4. Case 1. Prompt healing of ulceration after three applications of radon ointment indicating that ulcerated lesion was radionecrosis and not recurrent epithelioma.

applications of the ointment at weekly intervals. The lesion healed promptly indicating that we were dealing with radionecrosis (Fig. 4).

Case 11. N. W., aged fifty-seven, housewife, was referred to the Tumor Clinic on November

Fig. 5. Case 11. Somewhat atypical appearing basal cell epithelioma of nose.

14, 1939, for the diagnosis and treatment of a tumor at the tip of her nose, as indicated in the accompanying photograph (Fig. 5). This lesion which had been present for at least four years was a well epithelized granulomatous appearing mass of rather soft consistency with somewhat nodular border and measuring in all about 2×2 cm. Boeck's sarcoid was suspected because of the appearance and indolence of the lesion. A biopsy suggested but was not conclusive for basal cell carcinoma. Consequently surgical re-

Fig. 6. Case 11. Ulcerated lesion eleven months after primary healing of the epithelioma following surgical excision and radium therapy.

moval of the mass was performed on November 21, 1939. Histopathological study of the specimen this time revealed definitely that it was a basal cell epithelioma and surface radium ther-

Fig. 7. Case 11. Complete healing of ulceration after one application of radon ointment.

apy was administered from November 29 to December 6, 1939, to the granulating base left after surgical excision. A surface mold was prepared and loaded with four 25 mg. tubes of radium filtered by 1 mm. of platinum. The tubes were spaced about 1 cm. apart and placed at a distance of 7 mm. from the skin. The irradiated surface was approximately 16 square centimeters. Three hundred milligram-hours was administered daily for eight consecutive days for a total dose of 2,400 mg-hr. This amounted to approximately 1 millicurie-destroyed per square centimeter.

Within two months following such irradiation there was complete epithelization of the ulcerated surface. The patient was then examined at intervals of two months and remained free of disease until November 5, 1940. At this time she returned presenting the ulcerated lesion seen in the photograph (Fig. 6). The skin overlying the bridge and right ala of the nose had a scaly consistency. The ulceration as shown was elliptical in outline and measured 7 mm. in its longitudinal diameter and 3 mm. in the transverse. The edge of the ulceration was moderately firm. There was no tenderness. There were no palpable pre-auricular or cervical lymph nodes. It was again necessary to determine whether we were dealing with recurrent carcinoma or late radionecrosis. A therapeutic test of radon was deemed justifiable before performing a biopsy of the lesion. The complete healing obtained within one week after the first application of radon ointment left no doubt that the lesion had represented a radionecrosis (Fig. 7).

CONCLUSIONS

The infinitesimally small amounts of radioactive energy employed in the radon ointment could not possibly produce any effect upon carcinoma so that there can be no doubt, even in the absence of biopsy, that we were dealing with late radionecrosis in both of the above cases. The response to radon ointment was so prompt that even were biopsy ultimately necessary the period of delay prior to the institution of appropriate treatment would have been negligible. We have indicated how unreliable clinical evaluation and even biopsy may be in the important differentiation between radionecrosis and recurrent epithelioma. It is hoped that in the use of radon ointment as a therapeutic test a valuable adjunct may be added to the armamentarium of the radiotherapist.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-seventh Annual Meeting: Haddon Hall, Atlantic City, N. J., June 8–9, 1942.

EDITORIALS

GLASS WOUNDS

AMONG the grave dangers in the bombardment of cities are the wounds resulting from flying glass, and numerous references have been made in the English journals to this type of injury.[1] Quite recently Tyrrell,[2] in the *Proceedings of the Royal Society of Medicine, Section of Ophthalmology*, emphasized these injuries of the eyes and made a strong plea for a method to make the public conscious of the dangers of this type of injury. He discusses wounds in and about the eye from flying particles of glass and also the wounds of the lids which are fairly common. The great difficulty in the treatment of this type of injury is that most of the cases become septic unless the wound edges are excised and in such a small structure as the eyelid there is not much left to excise after the lid has been considerably lacerated by the flying glass.

But it is in the intraocular foreign bodies that the roentgenologist is particularly interested as examination of that type of case may be of some assistance to the ophthalmologist. In perforating injuries of the eye, glass, so Tyrrell says, has been the chief bugbear. He states that there is great difficulty in visualizing the glass within the eyeball even with the slit lamp, and also incidentally calls attention to the difficulty of its extraction. In glass injuries of the eye the surrounding tissues are frequently peppered with small glass fragments and in any attempt to roentgenograph these patients to discover an intraocular glass fragment the field is often obscured or the examination rendered useless by innumerable small particles of glass that lie in the adjacent tissues of the eyeball.

In the discussion of Tyrrell's paper it was pointed out that glass wounds are exceedingly common during air raids, especially from broken windows, but fortunately most if not all of the window glass is relatively radiopaque. Mr. Harold Ridley in his discussion gave a useful hint for the approximate localization of glass within the eye. He suggested roentgenographing the eye from front and side after fitting a Zeiss contact glass. The relative position of the shadows gives a good idea of the position of the foreign body.

The great difficulty of obtaining a clear image of glass within the orbital area is occasioned by the superposition of the bony structures. A few ingenious devices have been suggested for the determination of the presence of glass within the orbit, particularly within the anterior chamber. One suggested by Pancoast, Pendergrass and Schaeffer[3] is a fairly simple method, namely that of bending a dental film and pressing it gently between the lids and bony framework of the eye. With the lids widely separated an excellent image of the cornea may be obtained and a foreign body of specific gravity too low to be identified definitely on the usual localization film may be recognized. With the film placed horizontally below the globe and the direction of the rays through the top of the skull they have succeeded in identifying the object from two 90 degree angles. They point out, however, that this method is of use only if the foreign body is present in the anterior portion of the globe and cannot be recognized in the usual localization films.

Lewis,[4] in a careful roentgenographic

[1] Glass wounds, *Lancet*, Jan. 3, 1942, *1*, 14–16.

[2] Tyrell, T. M. Treatment of war injuries of the eye. *Proc. Roy. Soc. Med.*, 1941, *34*, 725–732.

[3] Pancoast, H. K., Pendergrass, E. P., and Schaeffer, J. P. The Head and Neck in Roentgen Diagnosis. Charles C Thomas, Springfield, Illinois, 1940, p. 535.

[4] Lewis, R. W. Roentgenographic study of glass and its visibility as a foreign body. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 853–857.

study of glass and its visibility as a foreign body, divided glass roughly into two groups: in group 1 he included barium and lead glass which have limited commercial uses; "ordinary" glass which he placed in group 2 is the type which one encounters daily, namely window glass, automobile glass, bottle glass, and the glass in clinical thermometers. In the roentgen analysis of the density of the shadows he pointed out the fact that a particle of "ordinary" glass might be expected to be shown clearly in the soft tissues.

Since most of the glass encountered as foreign bodies in blast injuries would be of the ordinary glass type and since injuries to the eye as well as other parts of the body from flying glass is so common in air raids, one should become familiar with the most suitable methods of localization and detection of particles of glass, particularly in and about the orbit. Of course, all parts of the body are subjected to glass injury but the glass imbedded in the extremities or in other parts of the body is more accessible and more easily recognized.

EFFECT OF HEAVY AIR RAIDS ON THE INCIDENCE OF PERFORATED PEPTIC ULCER

It has long been known or believed that peptic ulcer has seasonal variations. In the spring after a long winter with limited sunshine the increase in the number of patients passing through a hospital with a diagnosis of peptic ulcer is quite noticeable and this same increase is also noticeable in the fall of the year when people are returning from their vacations and are again thrown into the hurly-burly of daily work and its concomitant associations.

One of the most serious complications of a peptic ulcer is its perforation and it was noticed that after the beginning of the second week in September, 1940, when serious air raids on London began, seven patients with perforated peptic ulcer were admitted within a few days to Charing Cross Hospital which normally admits one a month. To discover whether this increase was more than a chance one, Stewart and Winser* decided to investigate the problem. They approached eighteen other London hospitals and asked to examine their records from 1937 to 1940 and of these all were visited except three, so that their analysis is from their own and fifteen other hospitals. They arbitrarily selected the period from January, 1937, to August, 1940, as this seemed to be an adequate length of time. They judged that their survey was loaded against any absolute increase of perforations in September–October, 1940, because the population of London was then at its lowest, total hospital admissions being lower still.

They found that the monthly average of perforated ulcers in the sixteen hospitals was 25 for the four years; excluding September and October, 1940, it was 23, whereas during these two months it was 64. The only recorded parallel to the increase which they had observed was in a report by Hamperl who found that perforations became at least ten times as common in a famine period in Russia.

In an attempt to discover the causes for such increases Stewart and Winser collected a rather long list of suggested etiologies for peptic ulceration and found that the possible etiologies could be summarized under certain headings, namely, acidity, vascular changes, miscellaneous drugs, trauma, bacteria and nervous stress. They discuss at some length the effect of bacteria as an etiological and causative factor in the perforations since Einhorn had reported that 56 per cent of his recurrences of peptic ulcer dated from common colds. Since air raid shelter life might offer a fertile source of infection this factor was analyzed and it

* Stewart, D. N., and Winser, D. M. de R. Incidence of perforated peptic ulcer; effect of heavy air raids. *Lancet*, Feb. 28, 1942, *1*, 259–261.

was found that the country's health was particularly good at that period so the bacteriological factor in the etiology in this group of cases was somewhat discounted.

The possibility of a nervous cause was examined at considerable length, citing the experimental and clinical observations of Cushing, McSwiney, Fulton and others that hypothalamic damage produces gastrointestinal disorders. Many observers have pointed out clinically the nervous factor as a precipitating cause of gastric and duodenal ulceration and perforation. Both English and American observers have called attention to this fact and Emery and Monroe in an uncontrolled survey stated that among 1,279 ulcer patients, in 334 fatigue and in 258 emotion and worry seemed to be the main precipitating factors.

From an analysis of their statistics it seems to Stewart and Winser that the probable causes of the September–October, 1940, increase in perforated peptic ulcer and also of Hamperl's Russian figures are anxiety, dietetic difficulties, and increased smoking and drinking. They believe that increase in smoking and drinking might partly be a result of the anxiety state in which these unfortunates found themselves. Their conclusion is that the significant increase in perforated peptic ulcer during the first two months of heavy air raids in September and October, 1940, might with justification find the probable cause in an anxiety state with the other possible factors being merely contributory causes.

JACOB JOSHUA LEVY
1879–1942

Dr. Jacob Joshua Levy, one of the outstanding roentgenologists of Syracuse, New York, died of leukemia in Rochester, Minnesota, February 22, 1942.

Dr. Levy was born in Elmira, July 12, 1879. He received his general education in the public schools of Syracuse and was graduated from Syracuse University with a degree of Bachelor of Philosophy in 1900. He was awarded the degree of Doctor of Medicine in the same institution in 1903. Dr. Levy was assistant professor in medicine at the College of Medicine of Syracuse University, attending physiotherapist at the University Hospital and the Syracuse Free Dispensary. He was a member of the American Roentgen Ray Society, the Radiological Society of North America, the Syracuse Academy of Medicine, the Onondaga County Medical Society, the New York State Medical Society, and the American Medical Association. He is survived by his wife, Marcella Green Levy, and two sons, John Green Levy and Donald Lovejoy Levy.

Donald S. Childs

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: Atlantic City, N. J., Oct. 6–9, 1942.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual meeting: Atlantic City, N. J., June 10, 1942.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N. J., June 8–12, 1942.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Arkansas. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting, 1942: To be announced.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Florida. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Greater Kansas City
Secretary, Dr. P. E. Hiebert, 811 Huron Bldg., Kansas City, Kansas. Meets third Thursday of each month at a place designated by the president.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society meeting. Next meeting New Orleans, April, 1942.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Hugh F. Hare, Lahey, Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. Paul C. Swenson, Presbyterian Hospital, New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport. Next meeting, Necho Allen Hotel, Pottsville, Pa., May 15–16, 1942.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho, Annual meeting in Denver, summer of 1942.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. L. W. Baird, Scott and White Clinic, Temple, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday each month, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress.
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

CONSERVATION OF SCHOLARLY JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this *Journal* in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, Rochester, New York.

ARKANSAS RADIOLOGICAL SOCIETY

The following group of radiologists met at the Freiderica Hotel in Little Rock on October 1, 1941, at which time the Arkansas Radiological Society was organized: Dr. W. R. Brooksher, Fort Smith, Dr. Fred Hames, Pine Bluff, Dr. D. Levine, El Dorado, Dr. C. H. Nims, Hot Springs, Dr. B. A. Rhinehart, Dr. D. A. Rhinehart, Little Rock, and Dr. J. S. Wilson, Monticello. Dr. Fred Hames of Pine Bluff was elected President and Dr. J. S. Wilson of Monticello, Secretary. Since the formation of the Society Dr. Ralph Law of Little Rock has become a member. The Society will hold a meeting every three months and also at the time and place of the meeting of the State Medical Association.

ANNOUNCEMENT

Recent action of the Executive Council authorizes the Treasurer of the American Roentgen Ray Society to remit the dues of any member formerly in civilian status who goes into any branch of the armed forces of the United States. The only requirement is a request, in writing, for such remission of dues. The action also authorizes the Treasurer to send the American Journal of Roentgenology and Radium Therapy to such members as long as they are in continental U.S.A., and to hold copies for them in the Publisher's office if they are sent overseas. All requests and information relative thereto should be sent to the Secretary's office.

H. Dabney Kerr, M.D., *Secretary*

University Hospital
Iowa City, Iowa

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Radiologic Physics. By Charles Weyl, S. Reid Warren, Jr., and Dallett B. O'Neill, Moore School X-Ray Laboratory, Moore School of Electrical Engineering, University of Pennsylvania. With a foreword by Eugene P. Pendergrass, M.D., Director of the Department of Radiology, University of Pennsylvania. Cloth. Price, $5.50. Pp. 459, with 158 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

In reviewing a book, one is always confronted with two major problems. The first is to decide for whom the book is written, and hence, adjust his viewpoint thereto; and the other is to examine the matter making up the book to see how it fits the needs of the person for whom it is written or who is most likely to read it. This book is apparently written to reach a new group of students. It should appeal to the graduate student in physics who has had little radiological background and requires a certain amount of review in order to present the picture of radiology in its correct aspect, or to the radiologist who has had very extensive training in physical and technical work and has, at the same time, had a moderate background in mathematics. Throughout, the book is replete with erudite discussions, digging into the very fundamentals of the mathematical and physical approach to the problems of radiological physics. In this respect the authors have been consistent throughout, and no mathematical detail is spared in the presentation of the principles involved.

The book is divided by the authors into two parts. The first deals with the theory and practice of electrical engineering, as applied to roentgen-ray apparatus. In this, the authors do an excellent job, and for reasons of completeness they digress here and there, wherever they deem necessary, from engineering into physics, thus introducing a complete mixture of the two. For example, in the second chapter entitled, "The Experimental Basis of Electromagnetism," the authors lead over adroitly into the fundamentals of atomic and nuclear physics, photoelectricity, ionization phenomena, etc., in which the connection to basic theoretical electromagnetism is fundamental and with which the radiological physicist should be acquainted. The third and fourth chapters deal with circuit analyses and electrical measuring instruments, and they give fairly complete presentations of the subject, well illustrated by solutions of very elaborate alternating current circuit problems in pages 60 to 70. This phase of their presentation is, as mentioned above, most important for the physicist who is somewhat prone to forget his electrical engineering in favor of the more fundamental physics. Here will be found a very excellent review. The same is true of Chapter 5 on transformers, generators, motors and electric power distribution systems—a field always somewhat foreign to the physicist. In Chapter 7 on electromedical apparatus, we find introductory presentations into electrocardiography, and here again is illustrated the completeness of the book, for in no book that I have ever seen before on radiological physics has the question of electrocardiography even been discussed.

Part 2 of this book deals with Radiant Energy and its Interactions with Matter. Here the opening chapter presents the theory of radiant energy and goes into fair detail in the field of optics, dealing with the fundamental phenomena of diffraction, refraction, and dispersion. From there it goes into the electromagnetic wave theory of light, and then logically into the quantum theory of radiation, with slight mention of the energy levels within simple atoms. About the first half of the book is taken up in this fashion, at which point the authors have laid a most exacting foundation for the presentation of roentgen-ray theory. The theory of roentgen-ray production and the more fundamental roentgen-ray effects, including ionization and diffraction are then condensed very nicely into the next thirty pages or so. Following this is a chapter on radioactivity and nuclear physics, presenting in outline a discussion of artificial radioactivity and penetrating radiations.

What should be the most important chapters now follow. "The Control of X-Rays and Gamma

Rays" presents an exceedingly brief discussion of roentgen-ray standards and one type of clinical dosage meter. This chapter starts with a very learned discussion in which the authors endeavor, and to a considerable extent succeed, in untangling the confusion between intensity as used in the optical sense and intensity as used in roentgen-ray dosage discussions. The opening paragraphs of Chapter 11 exemplify the completeness in this regard where they discuss the significance of the "point" at which radiation is measured, showing clearly that this is to be considered as abstract concept and not as a real but infinitesimal volume in which the radiation is measured. Following this is a brief discussion of roentgen-ray quality expression by means of absorption measurements.

The chapter on the use of roentgen rays and gamma rays, instead of just giving information which is of use to the clinical radiologist (and which may be obtained from any number of standard handbooks), presents the fundamental theoretical considerations involved in tissue dosage and depth dosage expressions. In keeping with their policy of avoiding the more mundane considerations, this chapter is essentially devoid of any information regarding techniques and precautions in the use of thimble ionization chambers, except for a short discussion of practical depth dosage and gamma-ray dosage. The choice of radiation therapy techniques, which is of great importance to the radiologist, and roentgen-ray and gamma-ray protection are taken up in the last four pages.

The last three chapters, dealing with the various aspects of roentgenoscopic and roentgenographic techniques, are very well presented indeed, since this is the branch of radiology in which the authors have had extensive experience. For the radiologist and technician these chapters should be very valuable, and to some extent this forms a convenient condensation of their earlier book dealing with the diagnostic aspects of radiology.

The introduction of the *mks* system of units seems to be in particular keeping with their policy of mathematical exactness. To my knowledge, this is the first time that this new system of physical units has been introduced to the radiologist. Most radiologists, as well as physicists, are accustomed to automatically associating certain numerical figures with certain physical constants, the association being through the classical *cgs* system of units. It is true that the *cgs* system has been used universally for many years and is thoroughly ingrained in all of us, but with the advent of the new *mks* system this book offers one of the first opportunities to divorce oneself from the bad habits he has been used to all of his life. I am sure that the radiologist will welcome the adoption of an entirely new system of units developed largely in the engineering profession for the purpose of simplifying many of the calculations and constants used in advanced technical work. Thus, the reader of the book is served with a commendable introduction to this new system of units which must surely at some time in the far future be used universally in the engineering profession. The delinquency in this is evidenced by the fact that of about fifteen men who have received a Ph.D. in physics within the last two or three years none has ever had any of his work presented in this newest and most modern system. The same is not true among the engineers of whom fully one-third have heard of the system.

The authors' idea of presenting an appendix giving a certain amount of mathematical review, particularly in calculus, is an excellent one. The radiologist has only occasional need for advanced mathematics much beyond the conventional arithmetic and can logically be expected to be rusty in the use of logarithms, trigonometry, geometry, etc. Consequently, this appendix must prove valuable to him when such mathematical requirements suddenly do descend upon him in the course of his work. The radiologist who masters this book will be a radiologist indeed.

The volume is beautifully prepared and published in accordance with Mr. Charles C Thomas' usual practice.

Lauriston S. Taylor

An Introductory Course for Medical or Premedical Students and Radiology Physics for All Radiologists. By John Kellock Robertson, F.R.S.C., Professor of Physics, Queen's University, Kingston, Canada. Cloth. Price, $3.50. Pp. 270, with 188 illustrations. New York: D. Van Nostrand Company, Inc., 1941.

There has been a definite need for a book covering the material presented in this volume; it will be welcomed by teachers and students alike. It is arranged as a text for the second year of a two-year course in premedical physics, and

from that point of view the order of topics is desirable; for the undergraduate who has recently completed an elementary course in physics, the abrupt plunge into alternating currents, which opens the first chapter, should not be discouraging. For the graduate student, or the practicing radiologist, something in the way of general introduction would have been desirable, and possibly some differences in order and emphasis would have been preferable. However, the material selected is ample for the purposes of either, and the book is eminently readable.

Following detailed discussions of roentgen-ray apparatus and circuits, consideration is given to the production, absorption, and measurement of the radiation, with some attention to dosage problems. Chapters on radioactivity, the elements of nuclear physics, and high frequency circuits complete the text. In the appendix are contained the International Recommendations for X-Ray and Radium Protection, and a very useful series of review questions. Mathematical treatments are reduced to a minimum, but accuracy is not thereby sacrificed. Abundant illustrations are very helpful. A weakness is the lack of references, particularly in the chapters on radiation dosage and on nuclear physics. Various authors are quoted, sometimes at length, but without a specific statement of the source, which is discouraging to those who wish to read further on these topics.

The book is well printed, and is a convenient size for ready use, not too large for comfortable reading, and at the same time not abbreviated by the omission of desirable material. It should be a useful addition to the library of any radiologist.

Edith H. Quimby

Modern Physics of Roentgenology: For Physicians, Pre-Medical Students, Students of Physics, X-Ray Engineers and X-Ray Technicians. By H. M. Muncheryan, M.Sc., Professor of Physics, California College of Medical Technicians; Author of "A Laboratory Manual of X-Ray Physics." Foreword by Dr. Albert Soiland, M.D., Director of the Los Angeles Tumor Institute. Second edition, revised and enlarged. Cloth. Price, $6.00. Pp. 391, with 195 illustrations. Los Angeles: Wetzel Publishing Co., Inc., 1940.

For many years radiologists have asked for a good textbook on radiologic physics. Muncheryan's book "Modern Physics or Roentgenology" is one of three such books recently published, although it is a revised edition of an earlier work by the author. The book covers a wide field, and according to its subtitle has been written for "physicians, premedical students, students of physics, x-ray engineers and x-ray technicians." As a consequence of this scope, it obviously was impossible to treat some subjects in great detail. For example, roentgen therapy is rather inadequately discussed in a few pages in the appendix, which contain practically no information on the important rôle of scattered rays in relation to tissue dosage or on adequate dosage measuring methods. Although some of the physical phenomena underlying both therapeutic and diagnostic roentgen-ray procedures are discussed in greater detail in other chapters, the preponderant emphasis has been placed on diagnosis. Hence it would appear that another title, such as "Physics of Roentgen Diagnostic Procedures" would better have described the contents of the book.

As a matter of fact, the text would have greatest appeal and interest for roentgen-ray technicians. It furnishes a wealth of information on every phase of their work, starting from fundamental considerations of the structure of matter to darkroom technique and standard positioning techniques. The chapters on technical discussions of roentgen generators and tubes are especially valuable and instructive. Questions and answers following each chapter and also forming a large part of the appendix should be helpful to students of the subject. Many of the illustrations are instructive in their conception but poorly executed. References which are found partly in the text and partly in footnotes are incomplete and to a large extent confined to the work of one or two laboratories.

Some of the statements made in the book will not find united support. For instance, on page 367, the author states: "X-rays in discriminating quantities will produce stimulative effect in the living tissue." Generally speaking, one might question whether problems of this kind should be discussed at all by a physicist. This applies even more to such questions as comparative radiosensitivity of various types of cells and the mechanism involved in sterilization by roentgen rays.

In spite of some shortcomings, the book contains much valuable material and can be recom-

mended to students interested in the physical foundations of roentgenology.

Otto Glasser

The Intervertebral Disc: With Special Reference to Rupture of the Annulus Fibrosus with Herniation of the Nucleus Pulposus. By F. Keith Bradford, M.D., Houston, Texas, and R. Glen Spurling, M.D., Louisville, Kentucky. Cloth. Price, $4.00. Pp. 158, with 45 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

This monograph is a timely discussion of a subject which is receiving wide attention, is generally little understood and which is being frequently and often wrongly applied in industrial medicine as well as in other cases of low back pain. The authors have selected the most important abnormality of the intervertebral disc, namely, the rupture of the annulus fibrosus with herniation of the nucleus pulposus, for their main theme. They have prefaced it with brief discussions of historical background, and have considered embryologic, anatomic and general pathologic conditions.

Since the larger percentage of ruptured discs with posterior displacement are associated with sciatic pain, a group of twenty causes of sciatica is given along with useful points of differentiation from sciatica caused by nucleus pressure.

Diagnostically the authors stress the importance of a good history and a thorough clinical study by one versed in the type of examination needed. The clinical study is given precedence over the roentgen examination and the latter is never to be undertaken until all other measures have been thoroughly tried. In the technique of the roentgen examination it is important to make a subarachnoid injection using 2 cc. of the opaque substance.

Clinically, the presence of severe disabling back or sciatic pain is of greatest value in diagnosis and about 75 per cent of cases show alterations in sensation along the distribution of nerves from the site of the lesion. The pain is worse on exertion. The Laségue and jugular compression tests give valuable information and reflexes are usually modified.

Conservative treatment is described and is said to give good results. The detailed technique of laminectomy is given. The authors remind us that the disc is still abnormal after any treatment and may degenerate early or in late years because of loss of all or part of the elastic nucleus. Recurrence of herniation after operation is a possibility, occurring in 8 out of 168 cases of the author's series. This may be prevented by complete removal of unherniated as well as herniated parts of the nucleus.

Cervical disc hernias are less rare than commonly believed. Early operation is advised. Thoracic disc herniation is said to be unusual and of little practical importance.

This monograph collects much valuable information on the subject of herniation of the nucleus pulposus. However, many things cannot be stated positively and much is yet to be learned. In fact, the authors admit that our knowledge of the larger group of conditions of the type usually considered lumbosacral and sacroiliac strains is in a nebulous state. Their book should be carefully studied by every neurosurgeon and roentgenologist as well as by the traumatic and orthopedic surgeon. It is the best source of knowledge about the ruptured disc and will prove indispensable to those who wish to know more about the subject.

E. W. Hall

BOOKS RECEIVED

The Autonomic Nervous System: Anatomy, Physiology, and Surgical Application. By James C. White, M.D., Assistant Professor and Tutor in Surgery, Harvard Medical School; Chief of Neurosurgical Service, Massachusetts General Hospital, Boston, and Reginald H. Smithwick, M.D., Instructor in Surgery, Harvard Medical School; Assistant Visiting Surgeon, Massachusetts General Hospital. Second edition. Cloth. Price, $6.75. Pp. 469, with 92 illustrations. New York: The Macmillan Company, 1941.

Epilepsy and Cerebral Localization: A Study of the Mechanism, Treatment and Prevention of Epileptic Seizures. By Wilder Penfield, Litt. B., M.D. (Johns Hopkins), D.Sc. (Oxon., Princeton), Professor of Neurology and Neurosurgery, McGill University; Director of the Montreal Neurological Institute, and Theodore C. Erickson, M.A., M.Sc., M.D. (Minnesota), Ph.D. (McGill), Formerly Lecturer in Neurosurgery, McGill University; Assistant Surgeon, Montreal Neurological Institute; Now Associate Professor of Surgery, University of Wisconsin. Chapter xiv by Herbert H. Jasper; Chapter xx by M. R. Harrower-Erickson. Cloth. Price, $8.00. Pp. 623, with 163 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

Roentgen Diagnosis of the Extremities and Spine. (Ann. Roentgenol., Vol. xvii.) By Albert B. Ferguson, M.D., Formerly Director of Roentgenology, New York Orthopaedic Hospital, and Instructor in Orthopaedic Surgery, College of Physicians and Surgeons, Columbia University. Enlarged first edition. Cloth. Price, $12.00. Pp. 462, with 562 illustrations. New York: Paul B. Hoeber, Inc., 1941.

The Intervertebral Disc: With Special Reference to Rupture of the Annulus Fibrosus with Herniation of the Nucleus Pulposus. By F. Keith Bradford, M.D., Houston, Texas, and R. Glen Spurling, M.D., Louisville, Kentucky. Cloth. Price, $4.00. Pp. 158, with 45 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

Die Differentialdiagnose der Wirbelsäulentuberkulose. (*Fortschr. a. d. Geb. d. Röntgenstrahlen*, Ergänzungsband 60.) Von Priv.-Doz. Dr. J. E. W. Brocher, Genf. Paper, price, RM. 14.70; bound, RM. 16.20. Pp. 88, with 129 illustrations. Leipzig: Georg Thieme, 1941.

Die Deutung des Röntgenschichtbildes der Lungenspitzen bei Lungentuberkulose. Von Dr. Wilhelm Kremer, Ärztlicher Direktor der Heilstätten Beelitz und des Tuberkulosekrankenhauses Beelitz (Mark), und Dr. Leonore Retzlaff, Assistenzärztin der Heilstätten Beelitz. Cardboard. Price, RM. 3.60. Pp. 43, with 46 illustrations. Leipzig: Georg Thieme, 1941.

Estudio radiológico de la equinococcosis pulmonar. Por Manuel Arce and Francisco Arce, Jefes del Servicio del Departamento de Radiodiagnóstico del Hospital Asilo de San Rafael, Hospital del Niño Jesús y clínica de Pediatría de San Carlos. Colección Española de Monografías Médicas. Director: Dr. J. Puig Sureda. Paper. Pp. 75, with 36 illustrations. Barcelona: 1941.

Diagnostic Roentgenology. Ross Golden, M.D., Editor, Professor of Radiology, the College of Physicians and Surgeons, Columbia University: Director of the Department of Radiology, Presbyterian Hospital, New York. Renewal pages (more than 600). New York: Thomas Nelson & Sons, 1941.

Roentgen Technique. By Clyde McNeill, M.D., Louisville. Second edition. Cloth. Price, $5.00. Pp. 329, with 276 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

X-Ray Therapy of Chronic Arthritis (Including the X-Ray Diagnosis of the Disease): Preliminary Report Based on 100 Patients Treated at Quincy, Illinois. By Karl Goldhamer, M.D., Associate Roentgenologist, St. Mary's Hospital and Quincy X-Ray and Radium Laboratories; Formerly Roentgenologist, University of Vienna. With a Foreword by Harold Swanberg, B.S., M.D., F.A.C.P., Editor, Mississippi Valley Medical Journal and the Radiologic Review; Roentgenologist, St. Mary's Hospital and Blessing Hospital, etc. Cloth. Price, $2.00. Pp. 131, with 26 illustrations. Quincy, Illinois: Radiologic Reviewing Publishing Co., 1941.

Physical Medicine: The Employment of Physical Agents for Diagnosis and Therapy. By Frank H. Krusen, M.D., F.A.C.P., Associate Professor of Physical Medicine, the Mayo Foundation, University of Minnesota; Head of the Section on Physical Therapy, the Mayo Clinic; Member of the Council on Physical Therapy of the American Medical Association, etc. Cloth. Price, $10.00. Pp. 846, with 351 illustrations. Philadelphia: W. B. Saunders Company, 1941.

Diseases of the Nails. By V. Pardo-Castello, M.D., Assistant Professor of Dermatology and Syphilology, University of Havana, Member of the American Dermatological Association, etc. With a Foreword by Howard Fox, M.D., Professor of Dermatology and Syphilology, New York University, University and Bellevue Hospital Medical College. Second edition. Cloth. Price, $3.50. Pp. 193, with 98 illustrations. Springfield, Illinois: Charles C Thomas, 1941.

Medical Progress *Annual* 1940: A Series of Fifty-two Reports Published during 1940 in the New England Journal of Medicine. Robert N. Nye, M.D., Managing Editor. Cloth. Price, $4.00. Pp. 625. Springfield, Illinois: Charles C Thomas, 1941.

Abridged Scientific Publications from the Kodak Research Laboratories. Vol. xxii, 1940. Paper. Pp. 278, with numerous illustrations. Rochester, New York: Eastman Kodak Co., 1941.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave. Charleston, S. C.

SEMI-AUTOMATIC VACUUM DOUBLE CHAMBER FOR ABSORPTION OF RADON IN FLUID MEDIA*

By HANS KOHN-RICHARDS, PH.D.
CHICAGO, ILLINOIS

THE use of a specially prepared ointment containing radon for the treatment of injuries produced by roentgen rays and radium has been reported previously.[1] A special apparatus developed for the preparation of this radon ointment is described in the following article.

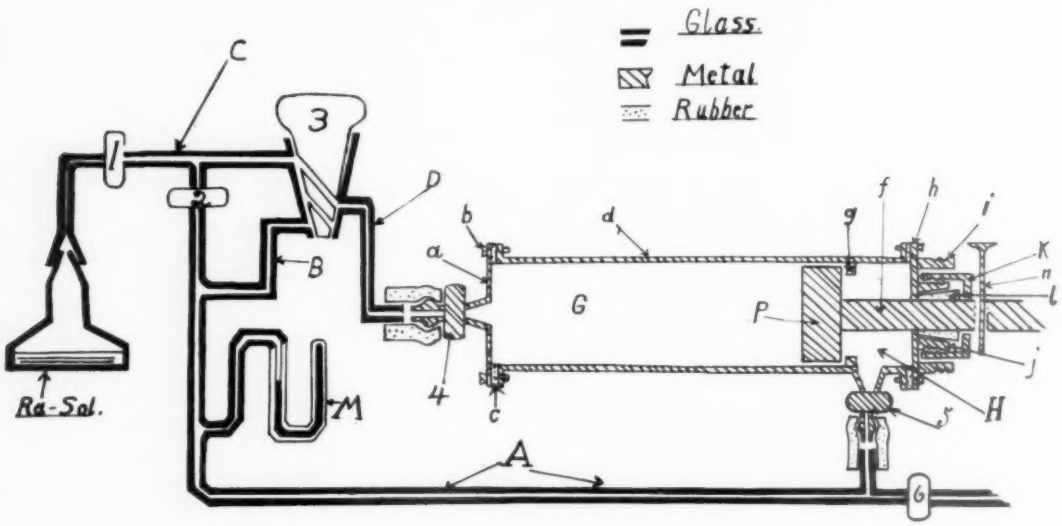

Fig. 1

This apparatus is designed for the collection of radon in ointment or other media which liquefy at a temperature low enough to prevent damaging the collecting chamber.

In order to transfer a maximum amount of radium emanation from radium container to ointment, the volume of the chamber must be very large compared to that of the radium container and its connections to the chamber. Conversely, the free volume of the chamber must be as small as possible in relation to the volume of ointment in order to permit a high concentration of radon in the ointment. Therefore, the chamber in which the radon is to be collected must first be evacuated at a maximum volume so that it may later be decreased to a minimum volume after being filled with radon. In a former construction, a plunger was used to withdraw air from the low pressure chamber. The volume could be changed by moving a plunger up and down by means of a threaded rod turned in a female screw which was maintained in a fixed position.

* From the Tumor Clinic, Michael Reese Hospital, Chicago, Illinois.

[1] Uhlmann, E. Treatment of injuries produced by roentgen rays and radioactive substances. Am. J. Roentgenol. & Rad. Therapy, 1939, *41*, 80–90.

In this construction, it was difficult to move the plunger because the air pressure upon it produced intense friction between the thread and the metal screw of the rod. Furthermore, the plunger had to fit the walls of the chamber tightly in order to prevent the entrance of air.

The principle of the double chamber obviated these difficulties. Since a low pressure is created on both sides of the plunger, it does not have to be ground to fit the chamber hermetically.

The radium is in the form of chloride or bromide dissolved in a few cubic centimeters of water and placed in a glass vessel (Fig. 1). This vessel is kept in a small lead box and communicates with other parts of the apparatus by means of glass tubing through a hole in the lead.

I. *The Double Chamber* (Fig. 2).

The chamber consists of a brass or steel tube about 10 inches long and about 2 inches wide. The bottom of the tube is covered by a metal plate, *a*, with an outlet and a metal cock, *4*. The plate is fastened very tightly on a flange of the tube by screws, *b*. Between the plate and the flange is a leather ring, *c*. By means of a rod, the plunger can be moved up and down between the plate, *a*, and the metal ring, *g*. This plunger divides the tube into two chambers, *H* and *G*, (Fig. 1). Near the right part of the tube *d* is an outlet with a metal cock, *5*. There is a metal plate, *h*, at the right part of the tube connected to *d* in the same manner as the plate at the bottom. A round threaded metal piece, *j*, is mounted upon the plate, *h*. Within this metal piece there is a perforated rubber stopper, *l*. This stopper prevents the air from penetrating into part *h* of the chamber between the rod *f* and the plate *h*. The stopper is kept in position by the perforated cap *k* screwed upon *j*. Another metal threaded circular cap *i* is mounted upon plate *h*. A large metal device, *v*, that will be described later can be screwed upon *i*.

II. The connection between the radium vessel and the chamber is shown in Figure 1. Pet-cock *6* leads to a suction pump. *A*

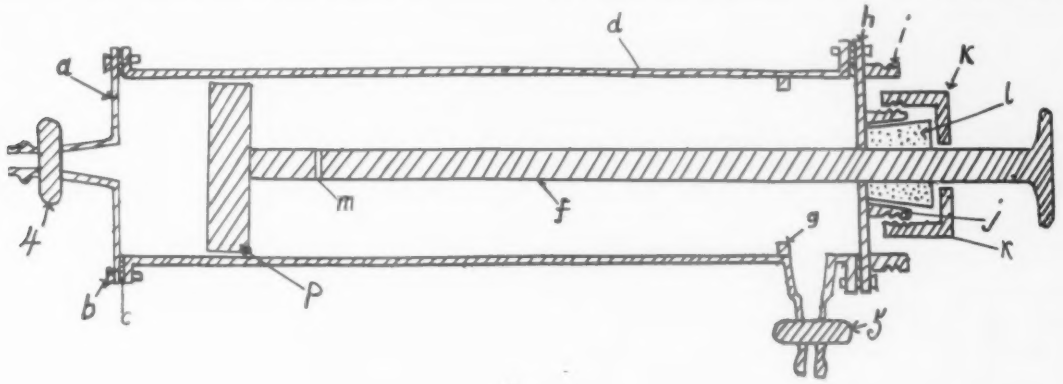

Fig. 2

communicates with a gauge, *M*, and is connected via *2* with the radium vessel or through *3* with the chamber. The radium container itself must be connected in airtight manner to cock *1*. Cock *3* is a three-way cock. The illustration shows *3* connecting *C* and *D*. If *3* is turned 180 degrees, *B* and *D* are connected to each other; if *3* is turned 90 degrees, *C*, *B* and *D* are all disconnected.

III. *Preparation of the Radium Solution.* The radium vessel is connected through cock *1*, *2* and *6* to the suction pump; cock *3* is completely closed and the glass outlet at *5* is closed by a piece of a solid glass rod kept in a piece of rubber tubing. The radium vessel is evacuated by the pump very slowly (in order to prevent the formation of large gas bubbles) until the mercury in the gauge indicates a constant pressure of about 10 to 20 millimeters of mercury. *1* and *2* are then closed and *6* is disconnected

from the pump. Note: The suction pump should never be closed before disconnecting it from outlet, *6;* otherwise water may flow backwards into the apparatus. The radium vessel will not remain under low pressure constantly; cock *1* should be opened only during the preparation of emanation ointment.

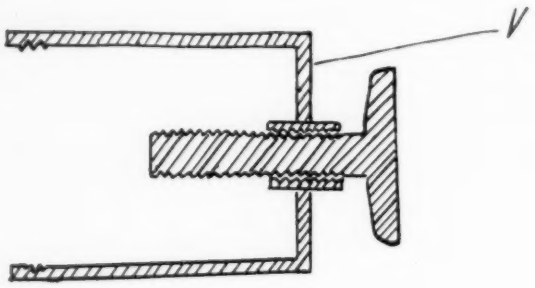

Fig. 3

IV. *Production of Emanation Ointment.* The plunger, *p*, is moved into the position indicated in Figure 1. This can be done either by pulling the shaft of the plunger out by hand, or by connecting cock *5* to the suction pump opening *5*, leaving *4* disconnected and open and while *2* and *3* are kept closed. The suction at *5* and the pressure of the air entering through *4* will bring the plunger to the required position. The chamber may now be connected as shown in Figure 1, thick pieces of rubber tubing being used to connect glass and metal parts.

The chamber is then evacuated as follows: Cock *3* is turned to connect *D* and *B; 4* connects *D* and the part *G* of the chamber, cock *5* in the open position connects *H* and *A*. Cock *6* is opened and the suction pump will evacuate both chambers and their connections. When the mercury in the gauge, *M*, falls to its lowest possible level, *6* and *5* are closed, *3* is turned to connect *D* and *C* and the pump is disconnected. It is necessary, from time to time, to make sure that *C*, *D*, *G* and *H* maintain their low pressure for about ten minutes, as indicated by the gauge. The set is left in above present position for about ten minutes. The gauge may be again evacuated through *6; 6* is closed and the vacuum in *H* and *G* tested by opening cock *5* and then turning cock *3* to connect *B* and *D*. If the gauge still shows a low pressure, the set is satisfactory. If the vacuum is not maintained, greasing metal cocks *4* and *5* will eliminate the leakage

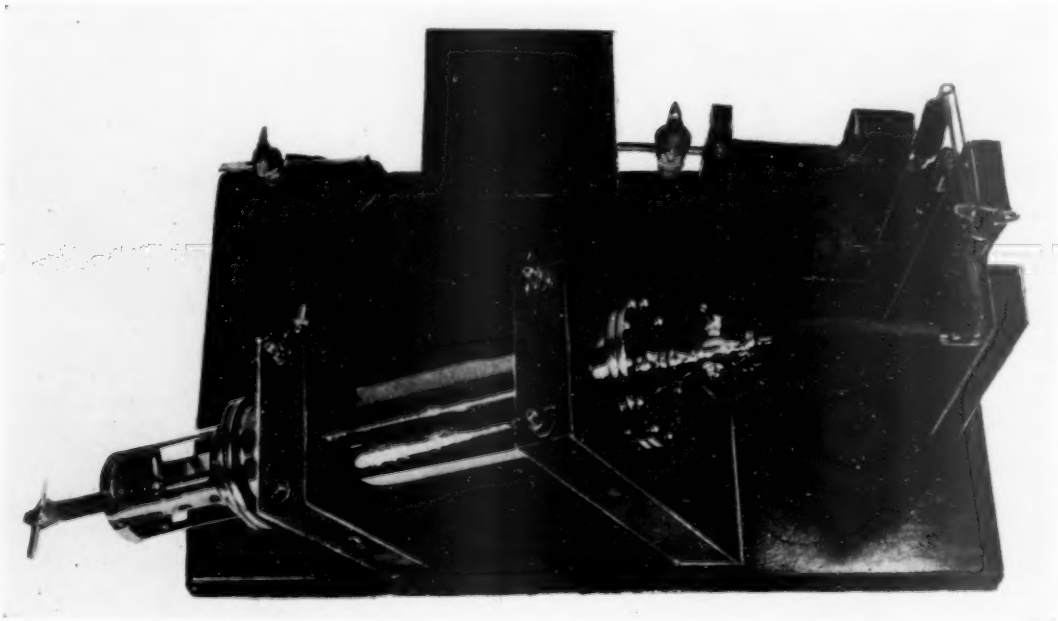

Fig. 4

(provided the apparatus is not damaged).

Cock *1* may now be opened. Emanation will flow by the way of cock *1*, *3* and *4* to space *G*. During this time a small metal pin, *n*, may be put into the hole *m* (Fig. 2) of the shaft. This will prevent the plunger *p* from suddenly sliding down, if air should inadvertently enter the chamber *H* (Fig. 1). Since *G* has a volume of about 300 to 500 cc. and the volume of the radium vessel and its connections to cock *4* is less than 40 cc., from 70 to 80 per cent of the radon will be in chamber *G* after seven to ten minutes. At this time, cock *1* is closed first and then *3* and *4*. The chamber is now disconnected at *4* and *5* and the pin removed from *m*.

The ointment will have been previously melted in a metal or porcelain vessel. The nozzle of the chamber at cock *4* is now dipped into the fluid ointment and *4* is opened slowly. The pressure of the air will drive the ointment into the chamber. When enough ointment has entered the chamber, *4* is closed. During the suction, one must be careful to prevent air entering through cock *4* (cock *4* must be opened and closed while the nozzle is still in the ointment). Cock *5* is now opened slowly and the air pressure will drive *P* down decreasing space *G* to a minimum and creating the optimum condition for dissolving a maximum amount of radon in ointment. Shaking the chamber for three to five minutes will improve the dispersion and distribution of the radon.

Application of the Ointment. When the ointment has solidified, it is difficult to force it through the outlet of cock *4* by moving the handle of the plunger by hand. Therefore, the device illustrated in Figure 3 can be screwed upon the threaded metal ring *i*. By opening cock *4* and *5* and turning the screw handle of device *V*, the ointment is pressed out easily.

There should always be a little grease or ointment in the chamber to prevent the flow of emanation from space *G* to space *H*. After some time, a small amount of ointment may penetrate from *G* to *H*. Carbon tetrachloride or alcohol sucked into cock *5* will dissolve this ointment; the fluid is then easily removed via outlet *5* with the plunger.

Figure 4 shows the apparatus assembled. The chamber is placed between wooden blocks with the nozzle at a higher level. The glass parts are mounted on the wooden frame. The glass parts are connected as described above and the metal parts by pieces of thick rubber tubing. While the rubber fits the glass and metal parts tightly the rubber connections are flexible to guard against breakage of the glass.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Cardillo, Furio, and Bossi, Renzo. La determinazione radiologica della capacità della sella turcica. Esperienze stratigrafiche. (The roentgen determination of the capacity of the sella turcica. Experience with stratigraphy.) *Radiol. med.*, Jan., 1941, *28*, 1–14.

Measurement of the capacity of the sella turcica is of great importance because of its containing the hypophysis. There are three ways of determining it: (1) by linear measurement of the diameters of the sella; (2) by measurement of the surface; (3) by measurement of the volume.

The authors discuss the different methods that have been used and then consider particularly the possibilities of determining the volume, showing how much more rational it is, in measuring the transverse diameter, to take the breadth of the floor of the sella rather than that of the back. In some cases this is impossible with the ordinary sagittal projection because of the difficulty of showing the floor of the sella distinctly in this projection. In such cases the desired object can be attained by using stratigraphy.

The authors have made a careful comparative study of 17 dried skulls. They made careful anatomical measurements and calculated the volume of the sella in each case by means of molds of a plastic substance. Then they determined the volume of the sella roentgenologically, calculating the area of the lateral projection of the sella by Haas' method and multiplying it by the third dimension, which is either the breadth of the back or the breadth of the floor. This was measured on stratigrams of each skull following the plane of a transverse section which passed through the floor of the sella. The stratigraph used was one of Italian make.

The results obtained in this way, using as a third dimension the transverse diameter of the floor, were closer to the real value of the capacity of the sella than were those obtained by using the width of the back of the sella. It is evident even theoretically that this would be true. A table is given showing the relative values for the different skulls by the two methods and the percentage of error. Comparative stratigrams and ordinary roentgenograms are also given.—*Audrey G. Morgan.*

Mucchi, Ludovico. Sulla diagnosi radiologica di ematoma endocranica traumatico. (Roentgen diagnosis of traumatic intracranial hematoma.) *Radiol. med.*, Feb., 1941, *28*, 92–98.

A case is described in a man of fifty-nine who was thrown from an automobile and struck on the left parietal region. He lost consciousness for three days. At the end of ten days he was discharged from the hospital in good condition but after a free interval of three days he showed exhaustion and mental torpor and the next day was picked up on the street unconscious. Clinical examination showed the signs of concussion of the brain. Encephalography showed marked displacement of the whole ventricular system to the right, especially the anterior part which was situated entirely to the right of the midline with a semilunar arrangement. Compression of

the right lateral ventricle which showed the occipital and temporal horns pushed downward; dilatation of the posterior part of the left lateral ventricle. No penetration of air into the subarachnoid spaces. As both clinical and roentgen signs indicated hematoma, operation was performed.

The whole of the frontal lobe and a large part of the parietal and temporal lobes were covered with a cap of hematoma. When the membrane was incised 500 to 600 cc. of coffee-colored blood was discharged. The patient made an uneventful recovery.

The chief condition from which intracranial hematoma must be differentiated is edema of the brain. In the latter condition the displacement of the ventricles is slight and involves chiefly the third ventricle and the changes may disappear quickly.

A second case is described, however, which shows that the differentiation between the two conditions may not be so easy. A man of forty-two fell and struck his forehead on the ground. He suffered intense pain but was able to go on with his work. Next morning however he had intense headache. He went to work but at the close of the day's work fell from a height of about 6 feet and struck on the left parieto-temporal region. When he regained consciousness he babbled incoherently and showed right hemiplegia.

Encephalography showed a picture similar to that in the previous case. Operation was decided on but was delayed for two weeks on account of a left zygomatic furuncle. During this time the patient's condition improved and he was able to get up and walk. Operation showed only slight residues of blood pigment. Puncture of the brain did not meet with any special resistance. The postoperative course was normal and the right hemiparesis improved greatly. Another roentgenogram showed only slight displacement of the ventricular system to the left and slight increase in the size of the third ventricle.

In this case there was probably only a moderate meningeal hemorrhage and an intense edema of the brain. A second ventriculogram just before the operation would probably have spared the patient the necessity of operation.—*Audrey G. Morgan.*

Wade, Leo J. Pseudo-platybasia: rupture of the transverse ligament of the axis with displacement of the odontoid process and compression of the cervical cord. *J. Bone & Joint Surg.*, Jan., 1941, *23*, 37–43.

Platybasia or basilar impression is a deformity of the occipital bone and the upper end of the cervical spine, variously attributed to rickets, osteitis deformans, osteomalacia, long-standing increased intracranial pressure, or developmental anomaly. It is characterized by an upward displacement of the clivus and a narrowing of the foramen occipitale magnum so that the medulla and the cervical cord are subjected to varying degrees of compression. The clinical picture is variable but often simulates disseminated sclerosis, syringomyelia, cerebellar tumor, or progressive spastic paralysis, depending upon the sites of pressure.

Wade's patient was a female, forty-five years of age, admitted to the hospital with the chief complaint of shortness of breath and swelling of the ankles and abdomen for the previous four or five months. At the age of sixteen she had fallen on her head, and was unconscious for a time and was said to be paralyzed on both sides for the following nine months. She had a "crooked neck" following the injury and had lameness, weakness, and an unusual gait, all of which persisted up to the time of her death. Neurological examination at the time of admission revealed a stiff neck, a Brudzinski sign on the left, absent corneal reflex on the right, a smooth face on the right with drooping of the corner of the mouth on that side, hyperactive biceps and triceps tendon jerks on both sides, slight spasticity of the right arm with increased resistance to stretch and little or no voluntary motion, absent abdominal reflexes, hyperactive knee jerks, marked bilateral Babinski sign, diminished sensibility to pain in both lower extremities, loss of voluntary motion of the right lower extremity, and incontinence of urine and feces.

Postmortem roentgenograms of the skull and upper cervical region showed a slight tilting of the skull on the cervical spine toward the right. The atlanto-occipital articulation of the right was narrowed and there was a break in the continuity of the basal occipital bone in the immediate neighborhood. This did not extend into the bone to any extent. The atlanto-occipital joint on the left was wider than usual. Crushing of the right half of the body of the atlas with some separation of the fragments had apparently occurred. This permitted the backward and left displacement of the odontoid process

which was found at autopsy. The roentgenographic findings did not suggest platybasia but seemed typical of an old injury.

At postmortem the cervical cord was found to pass through a small slitlike space located along the right lateral border of the foramen occipitale magnum and the cord appeared to be compressed. In the anterior portion of the left internal capsule and in the putamen an anemic infarct was found.

Wade thinks that the neurological findings during convalescence from the lesion in the left internal capsule and the degenerative changes found at autopsy in the tracts of the cord prove that the patient did have persistent bilateral pyramidal-tract lesions attributable to the injury sustained thirty years before her death. The degenerative changes in the pyramidal tracts below the site of compression were greatest on the left side, even though the infarct was in the left internal capsule. The left side of the cord was in nearest proximity to the displaced odontoid process. The odontoid process is held in position by a strong transverse ligament posterior to it, and it is unusual for the anatomical relation between it and the adjacent structures to be disturbed. Wade assumes that the trauma suffered by the patient was extremely severe to tear this transverse ligament.—*R. S. Bromer.*

NECK AND CHEST

Carter, Ray A. Pulmonary over-expansion in infancy and early childhood. *Radiology*, Oct., 1940, *35*, 391–401.

The author uses the term over-expansion rather than emphysema to emphasize the fact that it is a temporary condition. He discusses the technique of making roentgenograms of children, and describes and illustrates with roentgenograms several cases of over-expansion in infants and young children. There is considerable variability of aeration even in the normal infant. Deming and Washburn found that with the infant awake and quiet the pulmonary ventilation varied from 555.8 to 3,213.7 cc. of air, average 1,319 cc. When the child was crying it varied from 1,551.4 to 5,943.9 cc. with an average of 3,535.3 cc.

There are several mechanisms that may cause over-expansion. Perhaps the commonest is partial expiratory obstruction by foreign bodies, bronchial stenosis or viscid bronchial secretions. Deficient pulmonary ventilation may cause compensatory over-breathing and over-expansion. This may occur in congenital heart disease or pulmonary edema. Compensatory emphysema occurs whenever any considerable amount of lung tissue loses its ventilating capacity. This may occur in various diseases. The most common cause of infantile pulmonary hyperexpansion is acute respiratory infection and the generally accepted mechanism is resistance to expiration caused by viscid bronchial secretions. This may occur in all degrees of disease from mild tracheobronchitis to fatal pneumonia.

Over-expansion is seen less frequently as the child grows older. It is of interest and in some cases of diagnostic value.

In the discussion Dr. Wyatt said that the most frequent cause of pulmonary over-expansion at the Children's Hospital in Boston, as judged by postmortem examination, is bronchial obstruction by the viscid mucopurulent excretions of interstitial pneumonia. He discussed technique, mentioning the fact that children generally cry during these examinations and it is best to take the film at the beginning of expiration.

Dr. Newell said that the baby's bronchi are small and it does not take nearly so much swelling of the mucous membrane and thick mucus to plug them as it would in the adult.

Dr. Carter in closing said that proper technique is very important. Films taken in the supine position with quiet breathing are not always adequate. Special techniques are often necessary. Over-expansion of the infant's chest obscures many cases of real pneumonia, atelectasis and other pathological conditions. Kerley has emphasized the fact that the median location of bronchopneumonia in the infant conceals it behind the heart and mediastinum.—*Audrey G. Morgan.*

Malmros, Haquin, and Hedvall, Erik. The beginning of pulmonary tuberculosis in adults. *Am. Rev. Tuberc.*, May, 1940, *41*, 549–561.

The opinions described in this article are based upon routine and special studies concerned with 3,336 students at Lund University and the South Sweden School for Nurses. Tuberculin tests were conducted once or twice a year on all who were found to be negative reactors at the first examination. Roentgenograms were obtained on all positive tuberculin reactors, at short intervals.

The studies led the authors to believe that "pulmonary tuberculosis in adults began as a rule in the shape of initial foci. Radiologically these lesions have the appearance of minute and small, cloudy, partly irregular spots, usually situated somewhere in the supraclavicular region or in the first intercostal space." Even in those cases where a primary focus could be demonstrated, these features seem to characterize the beginnings of the "new lesions." These initial foci usually did not produce any subjective symptoms of disease nor increase in the sedimentation rate.

These "initial foci" correspond with lesions commonly described as "Simon's apical foci" but the authors do not believe that they represent early hematogenous spread, as is commonly believed. They may heal, indurate, become calcified or progress to serious degrees of phthisis.

The importance of combining roentgenological examinations with tuberculin testings is emphasized. The tuberculin tests should be made with dosages up to "1 milligram of tuberculin." If "initial foci" are discovered, careful supervision of the patient should be accomplished. Sanatorium care is considered necessary only if the initial foci show a tendency to spread or coalesce.—*A. A. de Lorimier.*

Cohen, Abraham G. Haematogenous tuberculosis with involvement of the larynx. *Am. Rev. Tuberc.*, April, 1940, *41*, 426–443.

It is usually taken for granted that tuberculous infections of the larynx develop as a bronchogenic extension from a lesion in the lungs. Yet many such cases are known to occur in individuals whose sputum is negative for tubercle bacilli and whose chest studies present the appearance of a healed condition. The author has collected such cases based on the following criteria: (1) the laryngeal symptoms appeared in a previously healthy individual or in one with an apparently quiescent tuberculous pulmonary lesion; (2) the sputum was free of tubercle bacilli; (3) roentgenography of the chest showed typical hematogenous lesions with no visible cavitations; in some cases (4) extrapulmonary lesions (besides intestinal) and (5) fairly recent miliary tuberculosis. Eleven such cases were studied, 4 which are described in detail. These were selected from about 250 cases of laryngeal tuberculosis received at the Montefiore Hospital during the past six years. In addition to the 11 cases which presented the rigid criteria for hematogenous infection, there were 44 additional cases which presented substantial evidence of such extension.

The author estimates that 30 to 40 per cent of all cases of tuberculous laryngitis are hematogenous in origin. The hematogenous type shows a predilection for the extrinsic portions of the larynx (the epiglottis, arytenoids, aryepiglottic folds), while with bronchogenic spread there appears to be a predilection for the intrinsic portions (true cords, interarytenoid space). The clinical and roentgenological features of the hematogenous group may present the same variety of manifestations as seen in cases of hematogenous tuberculosis without laryngeal involvement. The laryngeal symptoms may appear suddenly and the other manifestations of the hematogenous dissemination may follow. The majority of cases succumb to the immediate toxic effects of bacillemia. About 25 per cent of the hematogenous group survived whereas practically all of the bronchogenic type died. In most of the survivals, the larynx remained diseased with alternating periods of remission and exacerbation.—*A. A. de Lorimier.*

Andrus, Paul M. Chronic nonspecific pulmonary disease. I. The radiographic diagnosis of bronchiectasis. *Am. Rev. Tuberc.*, Jan., 1940, *41*, 87–98.

Four cardinal signs and two additional roentgenological considerations, relative to the diagnosis of bronchiectasis, are discussed:

1. Generalized increase in density of the pulmonary markings. This evidence was noted in approximately 100 per cent of the cases. In most instances, the involvement was limited to the lower half of the lung fields. Increased size and density of the hilar shadows were often associated. The author believes these changes to be due to actual thickenings of the bronchial walls or peribronchial tissues—as distinguished from purely mucous membrane disease. He speaks of the densities of bronchiectasis as "mural shadows" which are to be distinguished from vascular and infectious processes. Most cases will be found to have bronchial dilatation, though not necessarily.

2. Ring shadows. Eighty-five per cent of the author's series showed these. He describes the evidence as "gross whorls" completely occupying the region of a chronically collapsed lung

or as "honeycombs" of high-lights associated with a collapsed lobe or major section of a lobe. These densities are rarely as large as 1 cm. in their greatest dimension. Characteristically, there may be a chain of these rings along a heart border, curving outward over the domes of the diaphragm. The author explains that these ring formations are not dilated bronchi but usually significant of emphysematous air sacs.

3. Displacement of organs. Ninety per cent of the author's series showed this evidence. The heart and the diaphragm were most frequently concerned and the displacements were predominantly on the left side. Downward displacements of interlobar fissures were also noted. Explanation for these is considered to be varying degrees and repeated episodes of atelectasis—fibrotic shrinkage being a "less satisfactory explanation."

4. Chronic pneumonia. Such densities were found in 80 per cent of the series. They included flocculent or distinctly fibrotic shadows, varying from a single small patch to massive involvements of the lower half or more of both lung fields. The more advanced cases were manifested clinically by foul expectorations, decantation and clubbing of the fingers. The author emphasizes that "any chronic basal pneumonia must be regarded as highly suggestive of bronchiectasis."

5. Diaphragmatic irregularities. These changes were frequently noted but not of such high incidence as to be included among the cardinal signs. The varying degrees consisted of obliteration of one or both costophrenic sulci or a limited degree of tenting or scalloping of the diaphragmatic contours. When not otherwise explained, these irregularities might be related to patchy atelectases, rather than to purely pleural injury.

6. Luminal changes as visualized with iodized oil. These changes are considered to be sufficiently self-evident that this aspect need not be emphasized. The author does insist, however, "that a negative result from this method does not eliminate bronchiectasis as a diagnosis" and that "false negative findings are in no way rare or isolated events."

The presence of any one of these criteria warrants suspicion as to bronchiectasis. When two of the cardinal signs are well established, this suspicion is greatly enhanced; the presence of three or more of these signs warrants a diagnosis of the condition, ranging from probable to presumptive or positive depending upon the development of the shadows and the clinical associations.—*A. A. de Lorimier.*

Andrus, Paul M. Chronic nonspecific pulmonary disease. II. The pathogenesis of bronchiectasis. *Am. Rev. Tuberc.*, Jan., 1940, *41*, 99–103.

The pathogenesis of bronchiectasis is not definitely understood. Serial roentgenography of the chest provides a substantial analysis.

The author first considers the complications in massive atelectasis. He describes a freshly atelectatic lung as being homogeneously dense. Later, "ring shadows" develop. After instilling iodized oil into such cases, Warner has demonstrated not only extensive bronchial dilatations but "whorl-like" densities adjacent to them. These, he considers to be due to emphysematous bullae. The author considers that these changes are due to elastic hypertension with ectasia of both air cells and bronchi. These changes may occur when a whole lung is involved, when a single lobe is involved or when merely a section of a lobe is involved. The characteristic roentgen criteria include "pneumonia-like shadows, localized ring shadows and displacement of organs." Oftentimes, the collapsed sections of lung are concealed behind the heart shadow ("this being the single most common site both of collapsed lobes and of bronchial dilations") while the apparent changes may be located more peripherally. The author emphasizes the fact that many of the pneumonia-like shadows are due to atelectasis and that pneumonia itself more regularly undergoes complete resolution. Yet, he believes that pneumonia is the most common single cause both of bronchiectasis and of atelectasis.—*A. A. de Lorimier.*

Andrus, Paul M. Chronic nonspecific pulmonary disease. III. Classification. *Am. Rev. Tuberc.*, Jan., 1940, *41*, 104–114.

The author believes that the present classification concerned with chronic nonspecific pulmonary disease is not sufficiently indicative of the anatomical location or the character of the pathology. He therefore recommends the following classification:

I. Bronchial Tube Disease
  A. Reactive Injury (1) Mucous membrane reaction

		(2) Bronchial wall reaction
	B. Traumatic Injury	(1) Bronchial obstruction
		(2) Bronchial dilatation
II.	Air Cell Disease	
	A. Reactive Injury	(1) Pneumonia
		(a) Inflammatory
		(b) Organized
	B. Traumatic Injury	(1) Pulmonary collapse
		(2) Pulmonary overexpansion
		(a) Diffuse
		(b) Localized

Roentgenological evidence is lacking in the group described as mucous membrane reaction but clinically these patients are bothered with a chronic cough and expectoration.

A clinically similar group may show roentgenographic evidence consisting of generalized increase in density of the pulmonary markings, indicating changes in the bronchial walls themselves. "This type of shadow is often accompanied by abnormal prominence of the transverse aorta"— probably "related to an arteriosclerotic process." There may be enlargement of a heart with evidence of circulatory insufficiency. Such changes indicate a post-pneumonic type of injury. Thus, the author would distinguish between "catarrhal bronchitis (x-ray negative)" versus "mural bronchitis (vascular, infectious) (x-ray positive.)"

Traumatic bronchial disease may consist of obstruction or of dilatation or both. Bronchial obstruction is characterized by atelectasis. Bronchial dilatation is seldom visualized except when silhouetted by the aid of contrast media, though it should be suspected in the presence of isolated mural bronchitis, where there are no clues to suggest vascular origin.

Inflammatory air cell disease is usually recognized as a bronchopneumonia. When the involvement is limited to a localized patch, the most common site is regional to the apex of the heart. Depending upon whether the lesion is flocculent or stringy, the observer should consider either a preponderance of inflammatory reaction or of organization. The author would include in this category those cases presenting "wooliness" or "matting" along the course of bronchi—frequently as "interstitial pneumonia," but which, he believes, should be described as "suspect pneumonia."

Traumatic air cell injury may be distinguished by shrinkage or by overdistention. Essentially, shrinkage is based upon atelectasis. Fibrosis may be superimposed. Any such evidence should serve as a "sign post of bronchiectasis." Overdistention of lung tissue may be diffuse, as in a vesicular emphysema, or localized. Roentgenologically, a diffuse emphysema is characterized by abnormal blackness with contrasting outlines of pulmonary densities and with abnormal elevation of the rib shadows. Localized overdistentions are characterized by gross whorls or honeycombs.—*A. A. de Lorimier.*

Cutler, Elliott C., and Gross, Robert E. Actinomycosis of the lung and pleura. *Am. Rev. Tuberc.*, March, 1940, *41*, 358–367.

Actinomycosis is found in all parts of our country but particularly in the central plains. In the human, most of the infections are found in the face, jaw or neck (60 per cent). The next most frequent location is in the abdominal cavity (20 per cent). The bronchial tree, pulmonary tissues, pleura and the chest wall are involved in approximately 15 per cent of all cases.

The lesions produced are granulomatous in character, the center of a lesion consisting of a dense mesh-work of gram positive mycelial threads with a peripheral arrangement of radially disposed gram negative club-shaped rods—this surrounded by liquefied tissue containing exudate and polymorphonuclear leukocytes as well as lymphocytes and endothelial phagocytes. Older lesions are surrounded by a vascular connective tissue. This feature may produce a firm grittiness and suggest neoplastic disease. In the chest, this reaction may be an inch or more in thickness. The exudate may contain small sand-like granules—sulphur granules. Microscopical examination of these should reveal actinomycosis colonies.

In contrast with tuberculosis, actinomycotic involvement of the lung is usually found in the central or lower portions. The defense mechanisms, particularly with consideration of the endothelial phagocytes, may contribute to dissemination of the disease by carrying nonmotile organisms farther into the tissues and into regional organs. The disease may extend along vascular channels or by way of the blood stream to the liver, kidney, brain and other viscera.

The outstanding symptoms of pulmonary actinomycosis include cough, hemoptyses, malaise, fatigue, low grade fever and weight loss.

When the lung surfaces are involved, chest pains may develop. If the pleural cavity is invaded, a high fever and dyspnea may be produced. Occasionally, there may be no symptoms until distant organs are involved or until there be notice of pointings of a cutaneous abscess.

Roentgenologically, there are no specific criteria. The findings may include perihilar striations with extensions into the lower third or half of the lung; pleural thickenings; possibly osteomyelitis of the ribs and possibly massive empyema.

Various proposed regimens of treatment have been abandoned. At present, four methods show some promise: iodine therapy, thymol administration, roentgen therapy and surgery. The author recommends the administration of iodide by the use of fresh tincture of iodine in milk. Thymol may be given in capsules with dosages of 2 grams, three or four times a week, and it may be applied topically into sinuses or open lesions, using a 10 per cent solution in olive oil. Roentgen therapy is less effectual for treatment of pulmonary lesions than for treatment of cervicofacial lesions. Surgery should be radical but as applied to the thorax, it may be performed in multiple stages, particularly if cautery is used.—*A. A. de Lorimier.*

Perry, Kenneth M. A., and King, Donald S. Bronchiectasis. *Am. Rev. Tuberc.*, May, 1940, *41*, 531–548.

During the past ten years, the operative mortality for lobectomy in bronchiectasis has been reduced to about 10 per cent, as a general average, and to as low as 3 to 4 per cent, by certain operators. The authors have therefore reviewed 400 cases of proved bronchiectasis which were treated in the Massachusetts General Hospital during the years 1926 through 1938. This study deals with the natural course of the disease and statistics relative to complications and the mortality.

Two hundred and fourteen of the patients were males; 186, females. The case records indicated that 42 per cent of the group were less than ten years of age at the time of onset; 27 per cent between eleven and twenty years of age, and 24 per cent between twenty-one and forty. Their classification included four types: cylindrical, saccular, cystic and undetermined. In 53 of the cases the right lower lobe alone was involved; in 38, the right middle and lower lobe, while in 170, the left lower lobe or left lower and lingula were involved. In 55 cases, both lower lobes were involved. The authors emphasize this matter of frequency of involvement on the left side and suggest that this might be due to the fact that the right lower lobe is more easily drained or perhaps because of constriction of the left bronchus at the crossing of the left pulmonary artery or possibly because of the left bronchus being narrower than the right. Etiological factors considered include: mal-developments, upper respiratory infections with complicating drainage atelectases; actual pneumonic processes and foreign body aspiration. The authors are not inclined to associate paranasal sinus infections; they mention that chronic bronchiectasis may be responsible for flare-ups of sinus infection.

Complications to bronchiectasis *per se* include atypical pneumonia, lung abscess, cor pulmonale, brain abscess, empyema and pyopneumothorax and amyloid disease. Of the authors' series, 9 died of right-sided heart failure; 8 of brain abscess (in the right frontal lobe). Of 337 traced patients, 84 had died. Fifty-five per cent of the 260 non-surgical patients were traced and found to be living while 26 per cent were known to be dead. One hundred and forty patients were treated surgically, 14 of these by thoracoplasty; 10 by pneumonectomy; 116 by lobectomy. Of these, 109 were traced and found to be living. The operative mortality was 3.3 per cent in 122 lobectomies. In 71 of the lobectomy group, the results were considered to be excellent; in only 4 were they considered to be poor.

The authors conclude that non-surgical treatment can offer at best only palliation of symptoms. Deep roentgen therapy was carried out in 7 cases (method of treatment not described) but no clinical improvement resulted—though "it is possible that larger doses might have been more effective."—*A. A. de Lorimier.*

Dolley, Frank S., Jones, John C., and Skillen, Jane. Extrapleural pneumothorax. *Am. Rev. Tuberc.*, April, 1940, *41*, 403–422.

The subject of extrapleural pneumothorax is discussed in a controversial manner.

The authors have classified their cases very much as outlined by Schmidt, Adelberger and Theiss. Three groups are considered as "absolute," "broad" or "conditional" indications. The absolute indications include: (1) unsuccessful intrapleural pneumothorax; (2) cavities

neither fibrotic nor stiff-walled, not greater than 4 cm. and involvement above the sixth rib, posteriorly; (3) contralateral lung free of activity; (4) lesions recently active but non-acute—patient a good or fair surgical risk. Twenty-five such cases were treated with extrapleural pneumothorax. There were no deaths and every patient showed an apparent cavity closure with negative sputum. The broad indications are distinguished because of: (1) only fair circulatory or respiratory function; (2) cavities somewhat fibrotic, relatively large and possibly located at the lung periphery; (3) involvement of contralateral lung, and (4) involvement of years' duration with widespread though not marked fibrosis. Of 40 such cases treated by this method, 1 death resulted and 11 continued to show positive sputa. Conditional indications included: (1) poor physical condition; (2) old stiff-walled cavities in which thoracoplasty is contraindicated because of their size and position, and (3) contralateral cavities. There were 35 patients so classified; 4 of them died and 17 have positive sputum regardless of this treatment.

The authors conclude that: (1) intrapleural pneumothorax and limited thoracoplasty are to be preferred when they can be reasonably relied upon to produce cavity closure and sputum conversion; (2) when neither is likely to succeed extrapleural pneumothorax will obtain favorable results with approximately 63 per cent sputum conversions (based upon a review of reports on 2,000 cases).—*A. A. de Lorimier.*

Segal, Jacob. Intrapleural pressures in artificial pneumothorax. *Am. Rev. Tuberc.*, April, 1940, *41*, 461–470.

Pneumothorax is ordinarily accomplished with a neutralizing pressure. Dangers currently associated with high pressure pneumothorax include rupture of the lung, circulatory embarrassment and pleural effusion.

Various theories explanatory of these effects are discussed. The author has analyzed 104 cases treated by pneumothorax at the Riverside Hospital in New York; 43 of these developed fluid. Of 119 cases treated at the Fordham Hospital, 38 developed fluid. Yet ordinary collapse was instituted in all of these. The results of 12 cases treated with high pressure pneumothorax are compared. Three of these are described in detail—cases wherein ordinary collapse did not sufficiently obliterate cavitation but where compression of the cavities and reduction in the Gaffky ratings on the sputum occurred after forced collapse, using +10 to +15 manometric readings, in the expiratory phase. Excellent results were obtained thereby. In none of the 12 cases so treated was there evidence of circulatory embarrassment or rupture of the lung. All showed a remarkable absence of pleural effusion. The author concludes that though small volumes of air at frequent intervals under low intrapleural pressure is the preferred practice, nevertheless there are some cases wherein collapse must be forced under high intrapleural pressures.—*A. A. de Lorimier.*

Stone, Moses J. Clinical studies in asbestosis. *Am. Rev. Tuberc.*, Jan., 1940, *41*, 12–21.

The expanding usage of asbestos and the increased application of laws for compensation have compelled medical men to give greater interest to the general topic, pneumoconiosis, and to types of it such as asbestosis.

Asbestos varies in composition but in general it is a hydrated magnesium silicate with traces of iron and nickel.

The sputum of those afflicted may contain asbestos bodies—"a core of asbestos fibre surrounded by iron containing deposits." These bodies are golden yellow in color; they do not stain with ordinary histological stains but they become a brilliant blue when treated with potassium ferrocyanide. Pleural and even pericardial thickenings plus marked diffuse fibrosis with contraction of the lungs are prominent features. End arteries may be surrounded by fibrous tissue and they may contain thromboses. Many alveoli are obliterated by fibrous tissues, leukocytes and alveolar cells; others become emphysematous. Asbestos bodies may be found in the lumina of the bronchioles, in the alveoli and in the fibrous tissues. Amorphous brown pigment may be scattered throughout the lungs.

This report deals with 180 patients who had been subjected to asbestos contact by employment in a brake lining factory. Three stages of asbestosis are considered.

Clinically, Stage 1 cases showed definite limitation of chest expansion (less than 2 inches) and symptoms of lack of energy, cough, expectoration and possibly slight dyspnea. The roentgen evidence consisted of slight to definite film haziness (i.e., a ground glass appearance), particularly at the bases—the author believes that

in asbestosis, these changes are more granular than in silicosis, where nodular or patchy changes are likely to be found.

Stage II cases showed definite symptoms. The roentgen criteria included: (1) increased density, lower lung zones, tending actually to obliterate the outlines of the diaphragm; (2) limitation of movement of the diaphragm; (3) obliteration of the costophrenic sulci; (4) fine, lace-like network of interstitial or perivascular fibrosis, rather than parenchymal densities; (5) pericardial and pleural thickenings, and oftentimes (6) elevation of the diaphragm.

In Stage III, these findings are more pronounced and frequently associated with bronchitis or bronchiectasis.

Parenchymal tuberculous lesions were noted in 9 of the 180 cases. Of the 16 cases of advanced asbestosis, only one had active tuberculosis. The author finds "that bronchitis, bronchiectasis and broncho-pneumonia are more frequently associated with asbestosis than is tuberculosis."

Sixty per cent of the cases showed prominent pulmonary vessels. The transverse diameter of the heart was increased in 33 per cent (i.e., after excluding organic lesions). The enlargements may be as found in hypertension, in mitral stenosis or cor pulmonale and "cardiac embarrassment is of utmost importance as causation of early symptoms."—*A. A. de Lorimier.*

ABDOMEN

Smerchinich, Giovanni. La palpazione dello stomaco in proiezione laterale. (Palpation of the stomach in the lateral projection.) *Radiol. med.*, Jan., 1941, *28*, 44–46.

Sometimes pathological conditions in the retrogastric space are not visible on the ordinary roentgenogram as the stomach is so movable in the posteroanterior direction that no imprint is made on its posterior wall. The author recommends turning the patient from a frontal to almost a lateral position, at the same time exercising pressure on the anterior wall of the abdomen over the stomach. In this way the posterior wall is pressed against any object in the retrogastric space and an imprint is made on it.

Roentgenograms are given of 3 cases in which this manipulation was used. They all showed conditions that had not been visible before, the first an abscess of the omental bursa, the second a tumor of the pancreas and the third a tumor of the liver.—*Audrey G. Morgan.*

Stoppani, Franco, and Matli, Giuseppe. Peristalsi gastrica e ingesti solidi. Rilievi radiologici nello stomaco normale e operato. (Gastric peristalsis and solid ingesta. Findings in normal stomachs and those that have been operated on.) *Radiol. med.*, Jan., 1941, *28*, 15–27.

In making a roentgen examination of the stomach, using liquid barium, it is impossible to observe the movements of the mucosa and determine what part they play in the mixing and expulsion of the contents. The authors therefore decided to try the use of solid ingesta, making use of the olives that are ordinarily used for diagnostic purposes, and filling them with barium. In the normal stomach the mucous membrane formed grooves, along which these olives passed in Indian file to the pylorus, where they made a rotatory movement and passed one by one through the pylorus. This peristaltic movement which forced them along the greater curvature was carried out almost entirely by the mucosa of the greater curvature.

In stomachs on which gastroenterostomy had been performed the olives passed toward the anastomosis single file, as they did in the normal stomach, and when they reached the anastomosis underwent the same rotation and collected in a figure resembling the petals of a daisy, after which they passed through the anastomosis one by one. These findings are illustrated by roentgenograms. This behavior of the olives seemed to show that remarkable functional adaptation had been established in the resected stomach.

The authors believe that this method of examining the stomach with solid ingesta should be more commonly used, as in some cases it may show better than examination with liquids the functional integrity of the stomach that has been operated on as well as that of the normal stomach.—*Audrey G. Morgan.*

Golden, Ross, Leigh, Octa C., and Swenson, Paul C. Roentgen-ray examination with the Miller-Abbott tube. *Radiology*, Nov., 1940, *35*, 521–533.

In 1934 Miller and Abbott published a description of their new double-lumen tube for deflation of the small intestine. The smaller of the two lumens is connected with a small perforated metal tip around which there is a small rubber balloon. The balloon can be inflated and deflated by injecting or withdrawing air

through this lumen. There are three or four holes near the end of the larger lumen through which gas and fluid may be aspirated or fluid injected. The insertion of the tube through the nose requires some skill and experience. Its passage downward through the stomach and intestine can be followed by fluoroscopy. Spot films are necessary for a study of any constriction that may exist. As the tube passes through the intestine the intestine is deflated. It may take as long as five to seven days for the tip of the tube to reach the cecum. If the tip of the tube passes to the cecum without obstruction it shows that the ileus is paralytic. As deflation progresses the ability of the intestinal wall to contract is restored. Barium sulphate may be given by mouth or through the tube to outline any obstruction that may exist. There is no really complete obstruction of the intestine. If the intestinal contents does not pass it is due to paralysis of the intestinal wall. The clinical terms complete and incomplete simply mean that paralysis of the intestinal musculature has or has not occurred.

The use of this tube and deflation of the intestine has proved very valuable in the treatment of both mechanical and paralytic ileus. Seventy-six cases have been reported from the Presbyterian Hospital in New York in which the mortality was approximately 16 per cent. This included 7 early cases in which an unsuccessful attempt was made to pass the tube. Excluding these and counting only the cases in which the tube was passed into the small intestine the mortality was 5.9 per cent. This included cases in which peritonitis and gangrene of the intestine had occurred. Descriptions and roentgenograms of 10 cases are given.—*Audrey G. Morgan.*

Rigler, Leo G., and Lipschultz, Oscar. Roentgenologic findings in acute obstruction of the colon. *Radiology*, Nov., 1940, *35*, 534–543.

Though the fact has been obscured in recent years by the active interest in obstruction of the small intestine, acute obstruction of the large intestine is a very serious condition that often requires emergency treatment. A very important aid in the diagnosis of such obstructions is the scout examination of the abdomen without contrast medium. An anteroposterior roentgenogram is made with the patient supine and if possible a posteroanterior view with the patient standing. If this is impossible a posteroanterior view should be taken with the patient in lateral decubitus, preferably on his left side. These roentgenograms should be of great value in diagnosis and differentiation from other acute abdominal conditions, particularly paralytic ileus and obstruction of the small intestine. In some cases the site of the obstruction can be determined.

In cases caused by congenital lesions and cancer a barium enema examination is necessary for confirmation of the diagnosis. But in acute obstruction caused by volvulus of the sigmoid colon it should be possible to make the diagnosis from the simple roentgenograms alone. The diagnosis can be made from the size and position of the sigmoid flexure, the presence of fluid levels and of a double point of obstruction. Cases illustrating this diagnosis are described and illustrated with roentgenograms.

If surgery is not done at once perforation may occur in the cecum or occasionally at the site of the obstruction. In such cases repeated roentgenograms should be made to determine the degree of distention and if possible prevent perforation. If perforation does occur it can be demonstrated by the presence of free gas in the peritoneal cavity. This can be shown by the ordinary scout film with the patient supine. The loops of small intestine are distended with gas and the outer as well as the inner walls can be seen.—*Audrey G. Morgan.*

Allen, Kenneth D. A., and Jamison, John H. The behavior of the small intestine during urinary tract irritation. *Radiology*, Nov., 1940, *35*, 544–545.

It has been recognized generally among roentgenologists and urologists that irritation in the urinary tract causes increased intestinal gas. But little if any work has been done to determine whether the meteorism is caused by gas in the stomach, small intestine or colon. The authors made a study to determine the occurrence of gas in the small intestine in cases of irritation of the urinary tract. Studies were made of 500 roentgen examinations, 250 of them in patients with irritation of the urinary tract, from stones of the ureter or kidney or from the presence of catheters; 250 of the subjects were apparently normal.

There was gas in the small intestine in 45.2 per cent of the cases with irritation and in only 1.2 per cent of the cases without urinary irritation. The 45.2 per cent is a conservative estimation as the majority of the patients did not

have calculus but were only catheterized cases. In some of them the catheters had been in place less than thirty minutes and longer duration of the irritation might have caused gas to appear. In 9 out of 39 catheterized cases gas appeared in the small intestine in demonstrable amounts in less than thirty minutes.—*Audrey G. Morgan.*

Lofstrom, James E., and Noer, R. J. The rôle of intestinal intubation in the diagnosis and localization of intestinal obstruction. *Radiology*, Nov., 1940, *35*, 546–560.

The authors describe and illustrate with roentgenograms a number of cases of acute intestinal obstruction. The use of the Miller-Abbott tube has proved of great value in making an accurate diagnosis of such cases and deflation of the distended bowel by means of this tube has also greatly reduced the mortality. After the bowel has been deflated barium can safely be introduced through the tube to the obstructed point and the nature of the obstruction determined. In many cases intubation will show that there has been no mechanical obstruction and the patient will be spared an operation.

In the discussion Dr. Holmes confirmed the value of the Miller-Abbott tube. He referred to 2 cases of unexplained dilatation of the colon and said that he had had similar findings in cases of syphilis of the central nervous system and wondered if Dr. Rigler's cases were syphilis. He mentioned another group of cases of obstruction caused by diverticulitis. These occur mostly in old people who are poor operative risks and they recover on rest in bed and treatment. It is therefore very important to differentiate them from cases of obstruction caused by cancer. He has had some trouble in cases of low obstruction of the large bowel in which the attending physician had given an enema which had passed beyond the obstruction and gave a misleading appearance. He advised against this practice.

Dr. Barker asked how to differentiate between large and small intestine when only a small part can be seen.

Dr. Newell said he, too, had sometimes been unable to differentiate between loops of large and small intestine and therefore he was in the habit of using the barium enema for the diagnosis of obstruction whether in the small or large intestine.

Dr. Carter said that acute pancreatitis sometimes causes a severe ileus of the transverse colon but not usually to the point of causing confusion with acute obstruction.

Dr. Garland said he had had considerable difficulty in the use of intubation and thought it required a special team for doing that kind of work. He asked Dr. Lofstrom whether he would again use intubation in the case of right pelvic abscess such as he had described. It seemed to Dr. Garland that the plain roentgenograms showed the diagnosis and that intubation was not necessary. He also said that he had found the separation of loops of small intestine by small amounts of fluid a very useful sign in diagnosing early strangulation and asked Dr. Rigler if he had found it so.

Dr. McNamee asked whether it was possible to determine the position of the lower end of the tube in the small intestine without the use of barium and why it was impossible to deflate the large intestine with the tube.

Dr. Lofstrom said they had been successful in the use of the tube in about 85 to 90 per cent of cases. He believed this was due to the care and attention to detail that had been given to the work. With regard to Dr. Garland's question on the case of pelvic abscess he said that any patient who shows distention of the bowel and signs of acute intestinal obstruction should be intubated.

Dr. Golden said that the most of their failures with intubation had been in the first ten cases and that since that they had had only one or two failures. One of the most important things in technique is the deflation of the stomach and repeated gastric lavage through the Miller-Abbott tube. As to the failure to deflate the colon, if the tube gets into the cecum the fluid there is so thick that it is impossible to suck it through the small holes in the tube. Cecostomy must be done to deflate the colon.

Dr. Rigler said that there was no syphilis in the two cases about which Dr. Holmes asked. He agreed with Dr. Holmes in regard to diverticulitis causing obstruction. In regard to the question of differentiating between small and large intestine he said that in general the colon tends to follow around the periphery of the abdomen while the small intestine is arranged in the middle. Distinction on the basis of the mucous folds is very difficult and the distinction is not always possible from the simple film of the abdomen. He has no objection at all to the use of barium enema but sometimes it is hard to use and the desired information can be obtained without it. He does think that the sep-

aration of the loops of small intestine by fluid is a valuable sign in strangulation. If a patient has signs of intestinal obstruction but they are intermittent and confusing careful examinaton should be made in the gallbladder region to see whether there is any evidence of gas in the bile ducts. If there is, the diagnosis of gallstone obstruction can be made without seeing the gallstone.—*Audrey G. Morgan.*

Cohen, Philip. Congenital intestinal obstruction, with special reference to the value of the plain roentgenogram for diagnosis. *Am. J. Dis. Child.*, Jan., 1941, *61*, 135–149.

Cohen states that in view of the greatly improved prognosis for congenital intestinal obstruction if operation is performed, it is important to arrive at a speedy diagnosis. He has found the roentgenogram made without using a contrast medium, by virtue of its objectivity, an invaluable aid in verifying the suspicion of congenital obstruction based on clinical observations. Of 4 of his patients with this condition who were operated upon, one survived.

He advocates the use of the plain roentgenogram for several reasons. First, it is a simple and harmless method, and the dangers attending the use of barium are avoided. Second, it is time saving. Third, the lesions are clearly shown, and the site of the obstruction in patients with atresia or stenosis is as well outlined as with the use of the barium medium. Fourth, it is objective and helps to convince a skeptical surgeon, who may be inclined to doubt a purely clinical diagnosis and advise watchful waiting until the diagnosis is established with certainty.

Cohen examined normal babies at different intervals after birth, in order to evaluate properly films of the abdomen in which spontaneously swallowed air was the contrast medium. A roentgenogram of a baby's abdomen made before it has taken anything by mouth shows a generous amount of gas in the stomach and in the intestine. This can be interpreted as due to the amniotic fluid swallowed by the baby during the process of delivery. If there is an obstruction, the swallowed air will not assist in visualization beyond the site of the obstruction but will clearly outline the dilated stomach, the duodenum or the coils of the intestine proximal to the obstruction.

Pyloric stenosis must be differentiated but in this condition the stomach, while large as outlined by air, does not approach the size seen in the dilated stomach due to duodenal atresia or stenosis. There is also no dilated duodenum in pyloric stenosis.—*R. S. Bromer.*

Wichtl, Otto. Zur Pathologie des Psoas und des Psoasschattens. (The pathology of the psoas and the psoas shadow.) *Fortschr. a.d. Geb. d. Röntgenstrahlen*, Feb., 1941, *63*, 84–99.

The significance of the psoas shadow in roentgen diagnosis results from its proximity to such organs as the kidneys and the spine. Diseases of the muscle itself are rare but a primary pyogenic psoas abscess has been described. It is to be distinguished from a retroperitoneal abscess beneath the fascia such as sometimes follows appendicitis. Hematomas of the psoas occur occasionally following a traumatic rupture of the muscle. An injury producing this lesion in adult life will cause a separation of the epiphysis for the lesser trochanter in adolescence and a fracture of the lesser trochanter in the aged. The hematoma may be followed by extensive calcification necessitating operative removal. Of the primary tumors only a fibromyxoma of the tendon has been reported. An echinococcus cyst of the psoas has been observed.

The longest known alteration of the psoas is, of course, abscess secondary to a tuberculous spondylitis recognized roentgenographically by broadening or obliteration of the psoas shadow and by calcium deposits. If the spinal lesion is very small the psoas abscess may be the only roentgen evidence of the disease. The character and location of the diaphragmatic attachments determine whether a lesion in the first and second lumbar areas will dissect upwards into the mediastinum or downwards into the psoas. More rare is the occurrence of a psoas abscess secondary to an osteomyelitis of the spine and this may be confused with a paranephritic abscess or even renal tumor. A hemorrhage into the soft tissues following a vertebral fracture may behave as an abscess dissecting into the chest or down toward the pelvis. However, this phenomenon is usually obscured by the severe meteorism which accompanies spinal injuries.

Metastatic neoplasms involving the vertebral bodies may deform the psoas contour and lymphogranulomatous infiltrations have been reported, as well as rare spinal conditions such as giant cell tumor, myeloma, and primary vertebral sarcoma producing similar changes.

The caudal portions of the kidneys overlie the anterior surface of the psoas. In para- and

perinephritic abscesses the contour of these soft tissues is often but not invariably lost. The contours may also be obscured with a hydronephrosis or renal tumor. A tuberculous perirenal abscess may behave as a spondylitic abscess and descend the psoas sheath. It is also to be pointed out that inflammatory disease of the pancreas may obscure the psoas border. Ureteral disorders such as periureteritis, hydroureter, and rupture from a calculus may affect the psoas shadow. Appendicitis and occasionally salpingitis may be a source of psoas abscess especially in children, and also mentioned in the literature are a necrotic diverticulum of the sigmoid producing a psoas abscess, a large aneurysm of the descending aorta which developed behind the psoas, and a malignant teratoma of the undescended testis which invaded the psoas bilaterally.—*W. A. Evans, Jr.*

Newcomer, Nathan B. The twenty-four hour gall bladder. *Radiology*, Nov., 1940, *35*, 575–584.

In addition to the points in regard to interpretation of cholecystographic findings given by Graham, Cole, Copher and Moore, the author thinks two other points should be considered: routine twenty-four hour examination of the gallbladder and mobility of the gallbladder. Normal gallbladders are supposed to be visible six hours after intravenous injection of dye; they are distinctly visible and normal in size and shape. Gallbladders that are only faintly visible are pathological. At the end of eight hours, after the first meal the normal gallbladder is half to two-thirds empty and after twenty-four hours completely empty.

The author believes that any gallbladder that is visible after twenty-four hours is pathological. He gives a table showing the findings in 577 cases, 230 of normal density and 254 of light density. The gallbladder was not visible in the other cases. Among the cases of light density, which are pathological in any case, 173 were still visible after twenty-four hours. Among the cases of normal density 134 were still visible after twenty-four hours. He divides these into four groups based on a correlation of twenty-four hour retention, gastrointestinal findings, history and physical examination. In grades III and IV surgery is practically always necessary. Among the cases visible after twenty-four hours in this group 83 were in grades III and IV.

A normal gallbladder moves upward and outward about 2 inches after a solid meal. If it does not do so it is almost certain not to empty in twenty-four hours. The lack of mobility is almost always due to adhesions. If a gallbladder is still visible after twenty-four hours a barium meal should be given and the history and physical findings correlated with the cholecystographic findings before the cases are graded or any recommendations made in regard to surgery.—*Audrey G. Morgan.*

Stevenson, C. A., and Sherwood, M. W. The roentgen diagnosis of cholecystocolic fistula. *Radiology*, Nov., 1940, *35*, 616–621.

The majority of cases of internal bile fistula are between the gallbladder and the duodenum. Up to this time only 5 cases of fistula between the gallbladder and colon have been described in this country. The authors add the reports of 2 more cases both of which were diagnosed by roentgen examination and one confirmed surgically. Operation was not performed in the other case as the patient was seventy-nine years old and his condition was compatible with life.

Such cases can be diagnosed by the presence of gas in the bile tract, failure to visualize the gallbladder after intravenous cholecystography demonstration of the fistula by barium enema and changes in the mucous membrane of the colon at the mouth of the fistula. This change in the mucous folds is not specific and is of value only in connection with some of the other signs mentioned. In both these cases the patients had had pain in the right upper quadrant of the abdomen which was relieved suddenly, apparently when the fistula was formed. Plain films of the gallbladder region can be used to demonstrate gas in the bile tract. This gas does not appear in fistulas of the gallbladder with any other organ than the digestive tract. Manipulation of the region of the hepatic flexure when the barium enema is given under fluoroscopic control is helpful in demonstrating these fistulas.—*Audrey G. Morgan.*

Somogyi, Gyula. Mit Hilfe der Röntgenuntersuchung diagnostiziertes Divertikel des Wurmfortsatzes. (A diverticulum of the appendix diagnosed by aid of the roentgen examination.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1941, *63*, 299–303.

Diverticula are now frequently diagnosed *in vivo*. Opinions differ as to whether they constitute a disease entity or whether they are a result of some more basic condition. Those of the first

opinion tend toward operative interference while the others are conservative.

The case is reported of a thirty-seven year old man who suffered for eight months from sour eructations. In spite of an ulcer diet and medical treatment he became worse and was recommended for operation. At the roentgen examination the duodenal bulb was observed to be spastic, but there was no organic deformity of the stomach or duodenum demonstrable. However, a diverticulum was observed in the cecal area and the roentgen diagnosis was diverticulitis consequent to a chronic appendicitis. The appendix was found at operation to be 10 to 12 cm. in length, with a pea-sized diverticulum communicating with its lumen near the attachment to the cecum. It was removed and the patient has been free of symptoms for three years. The morphological and histological findings indicated a true congenital diverticulum. Only 9 such diverticula have been reported and 4 of these were observed in the newborn.—*W. A. Evans, Jr.*

Beutel, A. Zum Nachweis nichtschattengebender Steine bei Fisteln zwischen Duodenum und Gallensystem. (The recognition of radiolucent stones in fistulas between the duodenum and the bile passages.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1940, *62*, 247–252.

The author has already reported that gallstone perforations are most often responsible for biliary-duodenal fistulas. In 153 fistulas reported by Judd and Burden, stones could not be demonstrated in only 32. Important in the diagnosis is the recognition of gas in the bile passages, first described by Busi in 1919. A further technique developed from that of H. H. Berg consists in maintaining the patient on the right side with the pelvis elevated for a long period after the ingestion of barium and with a compression apparatus the barium will enter the bile passages. Then, by having the patient walk about, some of the barium will escape leaving enough to outline the stone.

The first patient was admitted with chills, fever, intense jaundice and colic. Roentgen studies showed gas-filled bile passages. The barium studies done in the usual way showed a normal stomach and duodenum. Upon compression of the duodenum and elevation of the pelvis, the bile passages filled and the choledochus was seen to be markedly dilated. A filling defect was noted in the duct and this persisted after the patient walked about. Operation confirmed the roentgen diagnosis of a calculus, and a cholesterin stone the size of a plum seed was removed.

The second case was a seventy-nine year old invalid with abdominal rigidity, pain in the epigastrium, and slight icterus. There had been an attack of jaundice and colic in 1921 with repeated attacks since. Roentgenographically a pea-sized fistula was demonstrated between the apex of the duodenal bulb and the gallbladder which was contracted and showed many irregular filling defects. In the choledochus 2 cm. proximal to the papilla was a small hazel-nut sized rounded defect interpreted as a calculus. At autopsy eight months later the diagnosis was confirmed.—*W. A. Evans, Jr.*

GENITOURINARY SYSTEM

Bourne, N. W., and Hefke, H. W. Body section pyelograms in children. *J. Urol.*, March, 1941, *45*, 296–302.

Excretory urography has been disappointing in children due to the serious problem of intestinal gas shadows. This has been a source of much annoyance to those whose work lies mainly with children. Hefke conceived the idea of eliminating this difficulty through the use of body section urography. The authors used the type of apparatus which employs linear motion.

The patient is given castor oil or licorice powder, enemas and no breakfast. Five to 10 units of pitressin was administered if the survey film showed excessive gas. Intravenous diodrast was given in amounts of 10 cc. up to six years of age and 15 to 20 cc. above this age. In 50 per cent of cases no other technique was required. In the other 50 per cent body section films were exposed. The exposure was limited to one second because of lack of cooperation from the infants. On the resultant films intestinal gas shadows were so blurred that no interference was noted in the demonstration of the kidney pelvis, calyces, and parts of the ureter. Contrast and detail differ from the ordinary urogram. The entire film is streaky, especially at the edges. The authors include the summaries and films of 3 cases which show the value of their method.

In the first case the kidney areas were completely obscured by gas in spite of the use of pitressin, several enemas and licorice powder

the evening before the examination. Laminography demonstrated the pelves and calyces with remarkable clarity. In the second case the results were similar except that the patient had had no preparation. The third case had a history of hematuria. Routine urograms after careful preparation of the patient with castor oil and enemas were only partially satisfactory. Laminagraphy demonstrated a greatly dilated right ureter with a stone in the lower third. This had been obscured by the shadow of the sacrum on the ordinary film.

The films illustrated in this article offer an excellent argument for the method advocated. Pediatric urologists and roentgenolgists should welcome it.—*R. M. Harvey.*

Froug, C. Liposarcoma of the kidney: review of the literature and case report. *J. Urol.*, March, 1941, *45*, 290–295.

The author was only able to find 6 reported cases of liposarcoma of the kidney in the literature. He reviews these cases and reports a case of his own. His case was a white female, aged thirty, who had a left-sided abdominal mass which had been previously diagnosed polycystic kidney. This had been present for one month. Physical examination revealed a mass extending from the left costal margin to a point below the iliac crest. Bilateral retrograde pyelogram showed marked ptosis of the left kidney and a kinking of the ureter due to a large tumor mass which pushed downward. A perirenal air insuffiation combined with intravenous urography showed that the kidney was attached to the tumor mass. At operation the mass and the kidney were so firmly bound together that they were removed as a single mass. Roentgen therapy, 7,500 r, was administered postoperatively. No details as to the technique are given.

The upper pole of the kidney formed the lower pole of the tumor. The kidney pelvis was not distorted. No adrenal body could be identified. The histological diagnosis was liposarcoma of the kidney. The patient was alive one year after operation.—*R. M. Harvey.*

Johnson, C. M., and Smith, D. R. Calcified perirenal pseudohydronephrosis. *J. Urol.*, Feb., 1941, *45*, 152–164.

The authors admit that the name of pseudohydronephrosis is poorly chosen but use it to indicate hydronephrosis secondary to ureteral obstruction with a post-traumatic communicating perirenal cyst. Their case is the first described in which calcification occurred in the wall of the cyst. Their patient was a female, aged forty-one, in whom a mild hypertension and a mass in the left flank were found on routine physical examination. She had no symptoms but her history revealed a severe trauma to the left loin in childhood. The mass in the left flank extended from the iliac crest to the twelfth rib. A survey film of the abdomen showed a thin layer of calcification around a multilobular area in the left renal area. A left pyelogram showed the catheter extending to the lower border of the calcified mass and no medium was present above this point. At operation a single large cystic mass was found in the region of the lower pole and four small intercommunicating cysts in the region of the upper pole. A hydronephrotic renal pelvis drained into these small cysts. Histologic examination showed calcium deposition in the cyst wall, sclerosis of the renal tissue and almost complete destruction of the normal architecture.

Pseudohydronephrosis occurs when the renal parenchyma is torn so completely that a communication is established between the urinary tract and the perirenal tissues. Blood and urine collects within the limits of the perirenal fat and the fascia of Gerota. Complete healing may occur if hemorrhage is not severe and the ureter not obstructed. The perirenal fluid may be absorbed, become infected to form perirenal abscess or a perirenal cyst may result. If the ureter is obstructed urine will continue to extravasate into the perirenal space and a gradually enlarging cystic mass result. Finally calcification may occur. A brief review of the literature is included of calcified perirenal cysts demonstrated by the roentgen ray.

The differential diagnosis includes calcification in the walls of solitary cysts, calcified renal cancer, calcified tuberculosis of the kidneys, calcified echinococcic cysts and calcifications in neighboring organs.

Operation would appear to be contraindicated unless pressure symptoms are present. Surgical excision may be very difficult and even impossible.—*R. M. Harvey.*

Woodruff, S. R., and Lewis, W. F. The acute non-functioning kidney. *J. Urol.*, March, 1941, *45*, 303–314.

The authors have required an intravenous urogram on every patient studied directly or in consultation since 1937. In less than three years they encountered 51 cases of acute non-function of one or both kidneys. Cases of chronic nephritis, polycystic kidneys and renal disease requiring surgery were excluded. Twenty-six cases were associated with ureteral calculus. In the group showing the next most common incidence, the infective group, lies the authors' main interest. There were 14 cases in this group. External conditions causing acute renal non-function included 2 cases of ruptured kidney, 1 accidental bilateral ligation of the ureters during hysterectomy and 1 retroperitoneal hemorrhage. Toxic conditions producing anuria included 3 cases of nephritis secondary to foci of infection and 1 case of mushroom poisoning; 2 cases were reflex in origin, 1 after unilateral nephrectomy for hydronephrosis and the other following bilateral catheterization in the presence of a pathological kidney on one side.

In the 14 infective cases the chief complaint was sudden unilateral pain. Tenderness and vomiting were usually present. Urgency, frequency and dysuria were rarely found. A moderate fever and leukocytosis occurred. In each case the non-function indicated by the urogram was confirmed at cystoscopy by intravenous indigo carmine. The usual duration of non-function was twenty-four hours. Retrograde pyelograms showed renal infection in only 4 cases but ureteral infection was present in every case.

The history and laboratory findings coincided with what is commonly called acute staphylococcal infections of the kidneys, but in the authors' experience loss of renal function does not occur in such conditions. In the cases described by the author the symptomatic, roentgenographic and cystoscopic picture has been that of impacted ureteral calculus. Such a diagnosis has not been verified by careful examination and follow-up. They believe rather that they are dealing with a clinical entity of acute ureteral obstruction caused by infection, local swelling or local disturbance of an acutely angulated ureter. They conclude that care should be used in differentiating acute staphylococcal infections of the kidney from those with acute ureteral obstruction. They emphasize the desirability of the routine excretory urography in detecting non-function and suggesting the latter diagnosis.—*R. M. Harvey.*

Buisson, Mario. Ancora sul valore funzionale dell'urografia endovenosa. (Further points on the functional value of intravenous urography.) *Radiol. med.*, Feb., 1941, *28*, 77–83.

In an article in the Sept., 1940, number of *Radiologica medica* Fernandez wrote that kidneys with defective function give rapid and intense pictures of the pelvis on intravenous pyelography. The author holds that they give intense shadows, but do not give them quickly. The point that is of value in judging kidney function in intravenous pyelography is the time that elapses between the giving of the injection and the appearance of the shadow—not the intensity of the shadow. Therefore to get the best results it is necessary to take a series of roentgenograms beginning very soon after the injection and not more than a minute apart. This shows the time when the uroselectan appears in the calyces on both sides and the time required for the formation of the image of the pelvis, factors which are determined by the functional capacity of the kidney.

In the chromocystoscopic tests the appearance of the coloring matter in the urine depends not only on the excretory capacity of the kidney but also on the dynamic action of the ureter. The retarded appearance of the color may be due not to deficient kidney function but to some obstruction in the upper urinary tract.

Of course this does not mean that intravenous pyelography should replace the chromocystoscopic tests. The different methods of examination should supplement, not replace each other.

There are some cases in which opacification of the urinary tract is not possible, for instance in cases of polyuria, and therefore a large amount of urine with low concentration of opaque substance, associated with hypermotility of the pyelo-ureteral tract. Whatever the cause of the polyuria there are certain technical details that help to secure a good image in such cases: (1) The patient should be forbidden to drink any liquid for eight hours before the examination. (2) The amount of sodium chloride in the cleansing enema should be increased so as to draw salt into the large intestine and decrease the hydremia. (3) The patient should be quieted psychically; chilling, which causes tremor should be avoided, and he should be instructed to hold his breath while the exposure is made, as that is essential for a clear roentgenogram. (4) Great care must be used in the

roentgen technique and several roentgenograms without contrast should first be taken in order to determine the background on which the urograms will appear. With these precautions nearly all cases will give reliable images.—*Audrey G. Morgan.*

Boriani, Giuseppe. Un accorgimento per la migliore evidenza degli ureteri nelle pielografie. (A method for better demonstration of the ureters in pyelography.) *Radiol. med.*, Feb., 1941, *28*, 108–109.

Often in making pyelograms in renal colic it is necessary to determine whether or not there is an obstructing calculus in the ureter. This is difficult for often the ureters, particularly the lower part, do not show in such pyelograms, even when they are taken within three to five minutes from the time the contrast medium is given.

The author has found that definite information can be obtained in such cases by the use of the oblique projection. In intravenous pyelography the oblique projection shows the ureters when they are not visible at all in the ordinary dorsofrontal projection. It makes little difference whether the direction is from left to right or right to left, though if the right ureter is in question the direction should be from right to left and vice versa. Roentgenograms are given showing the invisibility of the ureters in a dorsoventral projection and their visibility in an oblique projection.

The reason for this better visibility may be one of two things: either the cross-section of the ureter is elliptical, so that it presents a greater thickness of opaque urine in the oblique than in the dorsoventral projection, or the oblique projection may free the ureter from tissues of equal opacity, between which it is lost in the usual projection. The author thinks it is probably due to a combination of these two factors.—*Audrey G. Morgan.*

Uhle, C. A. W. The significance of aneurysm of the abdominal aorta masquerading as primary urologic disease; case reports. *J. Urol.*, Jan., 1941, *45*, 13–40.

In the thirty-two year period there have been 14 aneurysms of the abdominal aorta in a series of 74,629 surgical admissions in the Philadelphia General Hospital. The author has personally seen 5 cases. All of these were in males. The commonest causes are syphilis in the young and arteriosclerosis in the aged. Abdominal aneurysms are usually sclerotic in origin. Destruction of the vertebral column is a common finding, the cartilaginous disc usually being spared. Since the abdominal aorta lies to the left of the vertebral column a left lateral oblique film will show the earliest changes. The usual cause of death is from hemorrhage following rupture.

A primary urologic disease will often be suggested by the symptoms due either to hemorrhage into the renal capsule, displacement of the ureter or kidney by the aneurysm or hemorrhage, or vertebral erosion and nerve pressure in the lumbar area. In the author's experience the following diagnoses were suggested by the patient's symptoms; perinephric abscess, renal colic, hydronephrosis, renal tumor and perirenal hemorrhage from trauma. His 5 cases are discussed in detail.

The author lists the following roentgen findings in aneurysm of the abdominal aorta; erosion of lower ribs, soft tissue tumor mass, obliteration of psoas shadow, lateral erosion of vertebral bodies, scoliosis of lumbar spine, calcification in sac, displacement of kidney and ureter, and impaired renal function. He emphasizes the importance of the lateral oblique view of the vertebral bodies for evidence of erosion.—*R. M. Harvey.*

Howard, H. H., Suby, H. I., and Harberson, J. Aneurysm of the renal artery. *J. Urol.*, Jan., 1941, *45*, 41–54.

Sixty-five cases of aneurysm of the renal artery have been reported to date. The authors add 3 new cases. Trauma is the most important etiological agent. Twenty-four of the reported 65 cases had a history of trauma. Severe infection is the next most common cause. Pain is the most frequent presenting symptom. Other symptoms are hematuria, abdominal mass, pulsation and bruit. An opaque ring-shaped shadow in the region of the renal pelvis on the roentgenogram is a very important finding. This must be differentiated from calcified cyst, calcified lymph node, calcified kidney abscess and renal calculi. Immediate nephrectomy is the surgical treatment of choice.

The authors summarize their 3 cases. In the first case, a woman of fifty-four, a right retrograde pyelogram is illustrated showing a large soft tissue tumor mass in the right upper quadrant with a densely calcified border and flecks of

calcium scattered throughout the tumor. The right kidney is displaced downward and rotated outward so that the upper and lower poles are parallel. The tumor mass seems to be in intimate contact with the medial border of the renal pelvis. A diagnosis of cyst was made but operation disclosed a renal artery aneurysm.

In the second case the roentgenogram of the abdomen gave no hint as to the presence of an aneurysm which was revealed by an exploratory laparotomy. No roentgen examination was made of the third case.—*R. M. Harvey.*

Wheeler, W. K. Periostitis pubes following suprapubic cystostomy. *J. Urol.*, March, 1941, *45*, 467–475.

Periostitis pubes is a definite clinical entity resembling acute bone atrophy rather than periostitis. The following are the characteristic findings: (1) it always follows suprapubic cystostomy; (2) tenderness and severe pelvic pain on motion; (3) adductor spasm of the thighs; (4) roentgenograms reveal mottled rarefaction of the pubis and ischium; (5) separation of bone and periosteum from the rami at sites of muscle tendon insertions, and (6) it is a self-limited disease requiring no surgical intervention.

The author summarizes the case records of 3 patients. Illustrative roentgenograms are shown. The syndrome could not be duplicated in experimental animals. There were two points which made the author question the diagnosis of periostitis in this syndrome. The decalcification jumped the cartilaginous symphysis and involved each pubis and ischium to the same extent. This is not characteristic of periostitis. In the second place healing occurred without excess new bone formation and with restoration of normal bone trabeculations. In periostitis excess bone formation should occur with alteration of the normal trabeculation pattern.

Because of these contradictions the author sought other bone diseases which might give such a picture and concluded that Sudeck's atrophy was such a disease. Atrophy of disuse, Paget's disease and tuberculosis were ruled out. He concludes that this syndrome is actually not a periostitis but a trophoneurosis of the nature of Sudeck's atrophy.—*R. M. Harvey.*

Rating, B. Zur Darstellung von Urethravarizen. (The demonstration of urethral varices.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1941, *63*, 214–221.

Dilatation of the urethral veins may follow acute or chronic inflammations, particularly gonorrhea and usually in those of advanced years. Other causes are thrombophlebitis, strangulation, and priapism. Occasionally urethral varices are associated with angiomas and other vascular anomalies, sometimes with prostatic hypertrophy and varicocele. Ultzmann has commented on the association of varicosities at the base of the bladder with rectal hemorrhoids. Vesical varices with bleeding are encountered in pregnancy. Extensive varicosities in the urethra are very rare, but the author reports such a finding in a man aged forty-five who had had hepatic cirrhosis for five years. Two years previously he had had hematemesis and esophageal varices were demonstrated. For a year there had been urethral catarrh and occasionally bleeding especially after coitus. There was a history of gonorrhea twenty years previously but no gonococci could be demonstrated at this time. A proprietary contrast substance (abrodil) in a dilution of 1 to 4 and in amounts of 20 to 40 cc. was used for retrograde injection of the urethra. The best visualization of the mucosa was obtained by partial emptying. By this means extensive varices were demonstrated in this patient. They were regarded as part of the same collateral circulation which includes the more common rectal varices. Venectasia, the common basis for urethral bleeding, is not demonstrable by this method although the site may be recognized by the filling defect formed by the coagulum.—*W. A. Evans, Jr.*

Peirson, E. L., and Wilson, S. A. A method of estimating the size of the prostate gland. *J. Urol.*, Jan., 1941, *45*, 82–91.

The size of the prostate gland is the determining factor in the type of operation to be performed in cases of prostatic obstruction. It is therefore important to have an accurate method of estimating the size. The authors feel that cystoscopy is the only method in common use that is more accurate than the one they propose, but they feel that preoperative cystoscopy is contraindicated. Their method consists in placing the patient in the supine position with the roentgen tube centered on the top of the symphysis. A Foley catheter is inserted into the bladder and its bag filled with 20 cc. of 40 per cent sodium iodide. The bladder is filled with 3 per cent sodium iodide and a film exposed after pulling the catheter down against the prostate. The height of the bag above the pubis

indicates the size of the prostate and the height above the floor of the bladder indicates the intravesical enlargement.

The patient is then turned on the side and a balloon is inserted in the rectum and filled with 6 per cent sodium iodide. A lateral film is exposed and the distance between the base of the bladder balloon and the rectal balloon indicates the depth of the prostate gland. Allowance must be made in the figures for distortion but the authors found the figures obtained in a series of 58 normal and pathological cases were sufficiently accurate for clinical purposes. A tube-target distance of 27 inches was used routinely. In the anteroposterior view the patient's legs must be extended and in the lateral view they must be flexed.

Several illustrative films are included in the article and a series of measurements obtained for the various diameters of the normal and abnormal prostate gland. They found considerable variation in the normal glands and little difference between the normal and the slightly enlarged gland.—*R. M. Harvey.*

Kickham, C. J. E. Diagnostic pitfalls in carcinoma of the prostate. *J. Urol.*, Jan., 1941, *45*, 92–101.

The author has been impressed in his study of cancer of the prostate with the following features: high incidence, insidious onset, vicious local extension and metastasis, clinical deceptiveness, difficulty of early diagnosis and incurability unless seen early. Radical perineal extirpation is the only hope for cure. Rich found cancer of the prostate in 14 per cent of 292 consecutive postmortem examinations on males over fifty, dying of a variety of causes. In 65 per cent of his cases the lesion could not be found on routine examination. This shows the difficulty of early diagnosis. Routine rectal examinations in males over forty is suggested. Suprapubic prostatectomy is futile in the presence of prostatic cancer.

Impairment of kidney function is the commonest cause of death in cancer of the prostate. Sudden onset of urinary retention without premonitory symptoms demands investigation of the possibility of prostatic cancer. About 60 per cent of these cases have genitourinary complaints as presenting symptoms. The disease may be mistaken for cancer of the rectum. Digital rectal examination is a prime requisite in the diagnosis and hardness or induration of the gland should be considered malignant until proved otherwise. Many cases will require biopsy for differentiation. Benign hypertrophy, prostatic calculi, and chronic inflammation are all to be considered in the diagnosis.

Osseous metastases occur in approximately 60 per cent of cases. In the author's series 87 per cent of these were in the pelvis. The lumbar spine was affected in 55 per cent. These sites are due to extension by the perineural lymphatics. The bone metastases are commonly confused with pagetoid changes. The phosphatase test may help to differentiate these two conditions.—*R. M. Harvey.*

SKELETAL SYSTEM

Stein, Justin J. Metastasis to bone from carcinoma of the gastrointestinal tract. *Radiology*, Oct., 1940, *35*, 486–488.

A table is given showing the bone metastases in 1,005 cases of cancer of the gastrointestinal tract seen at the Hines Hospital, Hines, Illinois, from January 1, 1931 to January 1, 1939. There were 34 cases of bone metastasis and the author believes the figure would have been much higher if specific studies for bone metastasis had been made in all the cases during hospitalization. Special roentgen study was made only in cases in which there were symptoms indicating involvement of bones. Most of the cases of bone metastasis from cancer of the digestive tract are of the osteoclastic type. In some of the cases in this series there were cells of both osteoclastic and osteoplastic types so it was hard to determine the exact nature of the tumor. Metastasis to bone may take place by either the hematogenous or lymphogenous route. Probably most of them take place by the hematogenous route as cancer cells can be found in the bone marrow vessels. There was in this series no parallelism between the degree of malignancy or size of the tumor and the probability of metastasis.

In a review of 1,625 cases of bone metastasis from various organs the bones must commonly involved were the spine, pelvis, ribs, femur and skull.—*Audrey G. Morgan.*

Stammel, C. A. Juvenile osteochondrosis. *Radiology*, Oct., 1940, *35*, 413–424.

In 1903 Osgood described the roentgen findings in a case of non-infectious, non-traumatic rarefying lesion of the tubercle of the tibia. The disease was named for him. Since then this same condition has been found in almost every bone

of the body except perhaps those of the head, and has been named for the finder. This has caused great confusion in the nomenclature and the understanding of the disease. The author suggests that all these cases be classified under the name of juvenile osteochondrosis, to differentiate them from the post-traumatic malacias in adults.

As a military surgeon he rarely sees the acute forms of the disease, though they may be seen in the children of military personnel and in CCC boys. What he is chiefly interested in is the late deformities caused by the disease.

He describes briefly and illustrates with roentgenograms the types of cases seen for the past four years at Fort Benning, Georgia, including 23 of osteochondrosis of the spine, or Scheuermann's disease, 3 of post-traumatic osteochondrosis of the spine or Kümmell's disease, 3 of osteochondrosis of the head of the femur, or Legg-Perthes-Calvé's disease, 3 of osteochondrosis of the tubercle of the tibia, or Osgood-Schlatter's disease, 1 of osteochondrosis of the tarsal scaphoid, or Köhler's disease, 1 of the epiphysis of the tarsal scaphoid, 3 of the os calcis, or Sever's disease, 1 of the head of the 2d metatarsal or Freiberg's infraction, 2 of the internal condyle of the femur, or osteochondritis dissecans, 6 of the carpal scaphoid, or Presier's disease, 2 of the semilunar, or Kienböck's disease.

The symptoms of the disease are mild and unless they cause later deformity, may pass unnoticed. The etiology is unknown. Many believe that it is caused by endocrine disturbance. It has been suggested that it is only a clinical syndrome that may be due to different causes.

In the discussion Dr. Clark said that he agreed that all these cases should be called osteochondrosis and that roentgenologists should learn to recognize the disease. He has seen cases brought into court in damage suits and diagnosed as fracture or injury of the hip joint when it was this disease which the patient had had since childhood. He believes, though he cannot prove it, that it is an endocrine disease.

Dr. Hubeny said the most interesting of these cases are the ones that show sclerotic changes in both ilia below the crests, commonly known as marble bone disease. He has been 3 cases of this in one family in which there were lines, usually construed as growth lines, in some of the long bones. These patients had been given phosphorized cod-liver oil as children and he wondered if heavy metals might have been deposited in the long bones, forming these lines. He wanted to examine the parents to see if the disease was familial but they declined to be examined. He wondered if in one of Dr. Stammel's cases with similar findings cod-liver oil had been given.

Dr. Kite discussed Legg-Perthes-Calvé's disease also called osteochondritis deformans juvenilis coxae. He prefers the descriptive name flat-headed femur. This is thought by some to be an endocrine disease but he does not think there is sufficient evidence of this etiology. Pyogenic infection of the hip gives a similar picture in some cases. In others low grade infection in the surrounding soft parts may be a factor. The treatment is to avoid weight-bearing during the plastic stage. This may be done by a caliper brace with a cork lift under the opposite shoe. If the patient cannot afford a brace a cork lift may be put under the opposite shoe and the patient may walk on crutches so that no weight is borne on the diseased side.

In closing, Dr. Stammel said that there was not much to be said regarding treatment. Usually the symptoms subside when the patient has attained full growth. In the spine deformity may be prevented by hyperextension while the disease is active. In regard to the patient referred to by Dr. Hubeny he said that he had been a healthy breast-fed baby and had not been given any medication for any length of time. Similar findings have been reported in scurvy. The boy may have had repeated mild attacks of scurvy when an infant.—*Audrey G. Morgan.*

Van Epps, Clarence, and Kerr, H. Dabney. Familial lumbosacral syringomyelia. *Radiology*, Aug., 1940, *35*, 160–173.

The authors describe cases beginning, generally in the teens, with calluses on the soles of the feet which ulcerate and heal slowly if at all. The condition is generally not painful unless infection of the ulcers occurs and the patient can remain on his feet. The toes become discolored and swollen and are removed piecemeal. The metatarsal bones later undergo the same changes. In cases of severe infection amputation may become necessary. The disease rarely extends above the ankle. Roentgen examination shows neurotrophic changes in the bones and joints of the feet. The neurological symptoms are very similar to those of syringomyelia. When cases of this kind appear a careful study

should be made of the family history for other cases.

Up to date 54 cases of this lumbosacral syringomyelia have been reported. The authors add 27 cases of their own, making a total of 81 cases. Of these 71 were familial and 10 sporadic. Of their own 27 cases 26 occurred in four families. In the other case there was no family history but in one other case that was at first thought to be sporadic 6 other cases were later found in the family.

Both the neurologic and roentgen findings may be seen in tabes but of course tabes does not show a familial tendency. The sporadic case showed partial Argyll Robertson pupils, primary optic atrophy and retrobular neuritis with slightly constricted visual fields. This may be a case of tabes but the characteristic changes in the feet are rarely seen in tabes.

The best treatment for this condition seems to be irradiation of the lumbosacral cord. Two of the authors' cases have improved under this treatment.—*Audrey G. Morgan.*

Fabiani, Fabio. Lussazione esterna totale della rotula datante da 25 anni. (Total external luxation of the patella persisting for twenty-five years.) *Radiol. med.*, Dec., 1940, *27*, 949–950.

A patient forty-two years of age was sent to the naval hospital because he reported that he was no longer fit for service. In an automobile accident twenty-five years before he had suffered various injuries, all of which had healed, leaving only a luxation of the left patella, which did not cause him any inconvenience except a slight limitation of extension and flexion of the limb and a change in the joint line of the injured joint. Recently after long marches, particularly in sand or mud, he had begun to have difficulty in using the injured knee and for this reason was sent home from the colonies.

The roentgenogram is reproduced as the author thought it worth while to show the changes produced in the joint by an injury of such old date.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

Baggenstoss, A. H., and Keith, H. M. Calcification of the arteries of an infant; report of a case. *J. Pediat.*, Jan., 1941, *18*, 95–102.

The authors have collected 9 case reports in addition to their own. Their patient was a baby girl, aged eight weeks, who was admitted to the hospital with vomiting, distention and marked dehydration. Her past history revealed a normal birth and absence of cod-liver oil administration. The child died four hours after admission. Autopsy revealed an enlarged liver and heart and tortuous sclerotic arteries in the mesentery, kidneys, and periadrenal connective tissue. The coronary arteries showed advanced calcification and distortion of the media. The ascending aorta and pulmonary artery also were affected. A summary of the reported cases revealed that all patients were very young, which brings up the possibility of the arterial calcification being congenital. Syphilis or sepsis, by producing primary injury of the blood vessels, may produce so-called dystrophic calcification. In 4 of the reported cases infection was present, and in one congenital syphilis. A third possibility is periarteritis nodosa, but the authors say that calcification has not been reported in healed periarteritis nodosa. Finally, disturbances of calcium metabolism with so-called metastatic calcification must be considered. This occurs in osteomyelitis, myelogenous leukemia, neoplasms, osteogenesis imperfecta, renal rickets, hyperparathyroidism, and hypervitaminosis D. In 4 of the cases reported in the literature renal disease was present. In such cases calcification is due to retention of phosphates in the blood with consequent depression of the calcium and its deposition in the tissues. The authors conclude that their case was due to infection or overdosage of vitamin D or a combination of both.—*R. M. Harvey.*

Brown, Samuel, McCarthy, J. F., and Fine, Archie. Cardiovascular dynamics; a roentgen kymographic study. *Radiology*, Sept., 1940, *35*, 290–306.

The kymograph is an instrument designed to record for permanent study the pulsations of the heart seen on roentgenoscopic examination. In 1928 Stumpf devised a multiple slit kymograph which made it possible to record the pulsations of the whole heart and great vessels on a single film. The kymographic apparatus is described in detail and a series of roentgen kymograms reproduced which show the pulsations of the normal heart and those in certain heart diseases such as coronary disease, enlargement of the heart, chronic valvular disease and aneurysm. Kymography is rarely of direct aid in diagnosis but serves to confirm the roentgenoscopic and roentgenographic findings.—*Audrey G. Morgan.*

GENERAL

Hubeny, Maximilian J., and Mass, Max. Roentgenologic aspects of metastases. *Radiology*, Sept., 1940, *35*, 315–321.

The authors advocate a closer roentgenologic and pathological study of cancer metastases in an effort to determine what, if any, rules govern their appearance. As a contribution to such a study they analyzed the bone and lung metastases in 1,365 cases of cancer autopsied at Cook County Hospital for the ten years from 1929 to 1938 inclusive. They conclude that the development of metastases is quite unpredictable. Convenient rules have often been adopted without sufficient statistical evidence of their reliability, such as "In carcinoma of the prostate pulmonary involvement is probably never present in the absence of skeletal metastases." As a matter of fact, the authors' table shows that approximately 27 per cent of the lesions that were visible roentgenologically in cancer of the prostate were in the thorax without bone metastases.

Statistics of the bone and lung metastases for the various forms of cancer encountered are given. The fact that the incidence of these metastases is greater than has commonly been believed is doubtless due to more careful and thorough roentgen and postmortem examinations. Bone metastases frequently occur early rather than late in the course of the disease. They often do not cause enough symptoms to attract the attention of the clinician. Doubtless surgery is often performed after bone metastases have developed which shows that more thorough search should be made for such metastases, as radical surgery is not advisable after their appearance.—*Audrey G. Morgan.*

MISCELLANEOUS

Ponzio, Mario. Physical doses and biologic doses. *Radiology*, Sept., 1940, *35*, 282–289.

From a discussion of the attempts to establish a definite relationship between physical and biological dosage in roentgen therapy the conclusion is reached that no such definite relationship has been established and from the very nature of things cannot be established. For practical purposes the determination of physical constants is important in therapeutic irradiation but the many and variable phenomena which irradiation produces in living tissue are the decisive factors in biologic dosimetry.—*Audrey G. Morgan.*

Braestrup, Carl B., and Blatz, Irving H. Physical factors of low voltage "contact" roentgen therapy. *Radiology*, Aug., 1940, *35*, 198–205.

Two types of contact roentgen therapy tubes are described and illustrated—that devised by Chaoul some six years ago and one devised more recently by Philips. Both of these operate at very low voltage, about 45 kv. constant potential with a maximum of about 50 to 60 kv., and a very short target-skin distance of 2 to 6 cm. The physical and technical characteristics of the two types of tubes are compared and graphs given showing the effect of filtration and distance on the depth dose.

The very high dosage rate and the relatively low depth dose produced by this technique are due to the short target-skin distance. The short target-skin distance principle may also be used with higher voltages but in that case a distance of not less than 10 cm. must be used. The outstanding advantage of this method is that a depth dose approximately the same as that of radium can be obtained. The quality of the rays differs only slightly from that of the conventional unfiltered low voltage techniques. Though the dose distribution approximates that of radium the dosage rate is much higher. This makes it necessary to use extreme care in giving the treatment as an erythema dose may be given in a few seconds. Accurate timing and close supervision are very necessary.—*Audrey G. Morgan.*

Bale, William F. The use of artificially produced radio-active elements as tagged atoms in biological research. *Radiology*, Aug., 1940, *35*, 184–191.

The Geiger-Müller counter for measuring the radioactivity of artificially produced radioactive elements is described and illustrated.

Instead of dealing abstractly with the use of artificially radioactive elements in biological research the author made some studies of iron metabolism in which the radio-isotope of iron was used as a tracer. Aliquots of this radio-iron were fed to anemic and plethoric dogs and the amount of tagged or radioactive iron in the circulation after feeding was determined. Tables and graphs are given showing the results. They show that the absorption of iron is to a certain

extent determined by the needs of the body for this element. Large amounts were absorbed by the anemic dogs, very little by the plethoric ones. Another series of experiments shows that no matter how great a surplus of labelled iron is injected the animal has almost no ability to excrete this material. These experiments show why the radio-isotope of iron is so valuable in following the course of iron metabolism.

Other ways of using the radioactive elements are discussed, for example the use of radiocarbon in the study of photosynthesis. Radiochlorine is being used in the study of the chloride volume of animals. Work with radioactive arsenic at the University of Rochester shows how a radio-element may be used to carry the sensitivity of chemical analysis to a point that ordinary chemical methods cannot approach. Radio-phosphorus has been used as a tagged atom in biological research probably as much as all of the other radio-isotopes together. The short half-lives of some of the elements make them unsuitable for such work.—*Audrey G. Morgan.*

Tuve, M. A. The new alchemy. *Radiology*, Aug., 1940, *35*, 174–183.

The new alchemy is the charging of old stable atoms that have been known from time immemorial with radioactivity, changing them in this way to atoms of a different chemical element. The author demonstrated the transmutation of rhodium into palladium and in answer to questions showed how radioactive elements may be used as tracers.

The history of the development of nuclear chemistry is reviewed. In this connection he discusses the question of the production of atomic power and says that it is as yet impossible to say whether atomic power can or cannot be utilized practically.

He also discussed the question of the selective effects of radiation and said that the practical question that is being studied now is to find a type that will greatly damage malignant cells without injuring normal cells. Since there is still no definite evidence of cancer except tumor growth the only basis for this research seems to be trial and error.—*Audrey G. Morgan.*

Haenisch, F., Lasser, K., Eisl, A., and Rump, W. Die Röntgentherapieanlage für 1 Million Volt Spannung im Allgemeinen Krankenhaus Hamburg-Barmbeck. (The roentgen installation for 1 million volts tension in the General Hospital Hamburg-Barmbeck.) *Strahlentherapie*, 1940, *68*, 357–404.

As a result of interest aroused by a visit to the United States in 1931 and the reports at the Fifth International Congress of Radiology in 1937 in regard to high voltage therapy a building was erected at the Hamburg-Barmbeck Hospital for the production of rays at 1,000 kilovolts. A detailed description with photographs is given of the building and the apparatus together with measurements of dosage, hardness of the rays, deep dosage, the distribution of the rays around the anode, protection against the rays and the energy of the radiation.

The dose delivered in the direction of the cathode rays, with 5 ma., a total filtration of 5 mm. lead and 1 mm. focus distance is 150 r/min. The hardness of the rays with a total filtration of 5 mm. lead corresponds to a half-value layer of 10.2 mm. copper. The best filter material for very hard rays is lead, but for the measurement of the half-value layer copper.

The percentage deep dose at 10 cm. depth with a half-value layer of 10 mm. copper, 60 cm. focus-skin distance and a large field is 49 per cent of the surface dose. The radiation running in the direction of the cathode rays yields more than twice as large a dosage and harder rays than that running at an angle of 90° to this direction.

Special protection is required, of course, against radiation of such hardness. In order to furnish protection at 3 meters distance with 5 ma., the primary radiation must be filtered through 11 cm. lead and the scatter through 0.9 cm. lead.

The amount of energy required for the production of a pair of ions in air is the same for ultrahard rays as for moderately hard and soft rays.

The advantages of 1,000 kv. radiation as compared with 200 kv. radiation are: the delivery of a larger dosage, greater deep dosage, particularly with a small entrance field, slight scatter, which runs chiefly in the direction of the primary radiation, and as a result less injury to the superficial layers and the tissue not directly in the path of the rays, and a more uniform irradiation at greater depths.

It remains for radiation therapists to determine to what extent these special properties of

high voltage radiation improve therapeutic results. Until this apparatus was installed the Germans had to depend on reports from other countries and though they were in general favorable there were some workers who did not see any special advantage from the use of supervoltage rays. They hope now to have reports from their own skilled roentgenologists.—*Audrey G. Morgan.*

Smereker, Hilda. Chemische Wirkungen der durch die Radiumstrahlen erregten ultravioletten Fluoreszenzstrahlung und Beziehungen zu Fragen des Krebses. (Chemical effects of the ultraviolet fluorescent radiation produced by radium radiation and their relation to cancer problems.) *Strahlentherapie*, 1940, *68*, 405–443.

This article shows that the ultraviolet fluorescent radiation produced by gamma and beta radium rays in blood pigments causes changes in substances which play a part in the metabolism of cancer. On irradiation of the body with ultraviolet light only the superficial tissue layers are affected by the irradiation, but the gamma radium rays, because of their very penetrating action, can produce ultraviolet rays in the deeper layers, which are never touched by direct ultraviolet irradiation, and make them effective there.

The experiments in irradiation described here were carried out with substances which were carefully examined by A. v. Christiani in his work on the chemistry of cancer and which have a biological effect even in very small quantities. The experiments were carried out by a biological method described by E. Maier and A. v. Christiani.

Cholesterin butyrate containing ergosterin and a substance, called by A. v. Christiani entactivator, and described as an oxidation product of ergosterin, were irradiated with gamma rays and the supplementary fluorescent radiation of hematoporphyrin and human blood. The effect of the intensity of the gamma radiation and the region in which the fluorescent irradiation was effective, were studied. The experiments showed that the radiation of cholesterin butyrate with gamma rays, as a result of the oxidizing action of the rays, produced the biologically ineffective form of the entactivator from the ergosterin, but that when the fluorescent radiation of hematoporphyrin or blood was used the active form of entactivator was produced. The effective wave lengths lay in the ultraviolet region between 260 and 300μ, and possibly there were some effective components below 260μ.

In addition to the experiments with gamma rays others were carried with gamma radiation mixed with a high percentage of beta radiation. They were carried out in such a way that the effect was practically entirely due to the fluorescent radiation.

The ineffective form of the entactivator was irradiated with the ultraviolet light of a quartz mercury lamp and the resultant curve was similar to that obtained on irradiation with beta or gamma rays and the supplementary fluorescent radiation of hematoporphyrin or blood. This seemed to confirm the results of the work on the chemical effectiveness of ultraviolet fluorescent radiation.

A. v. Christiani showed that the active and inactive forms of the entactivator are probably modifications of the same substance.

The biological problems involved in regard to radium therapy are discussed. It is known that the entactivator is contained in normal serum and the serum of patients free of cancer but that it has not been demonstrated heretofore in the serum of cancer patients. But after the patient has been treated with radium it can now be demonstrated in cancer serum also. It was found in the fluorescence experiments that the gamma-ray intensities and doses necessary to produce the effective form were practically the same as those that have been in use in the radium treatment of cancer.

It is shown that processes produced by ultraviolet radiation and gamma or roentgen radiation can be explained in the same way from the standpoint of this article.—*Audrey G. Morgan.*